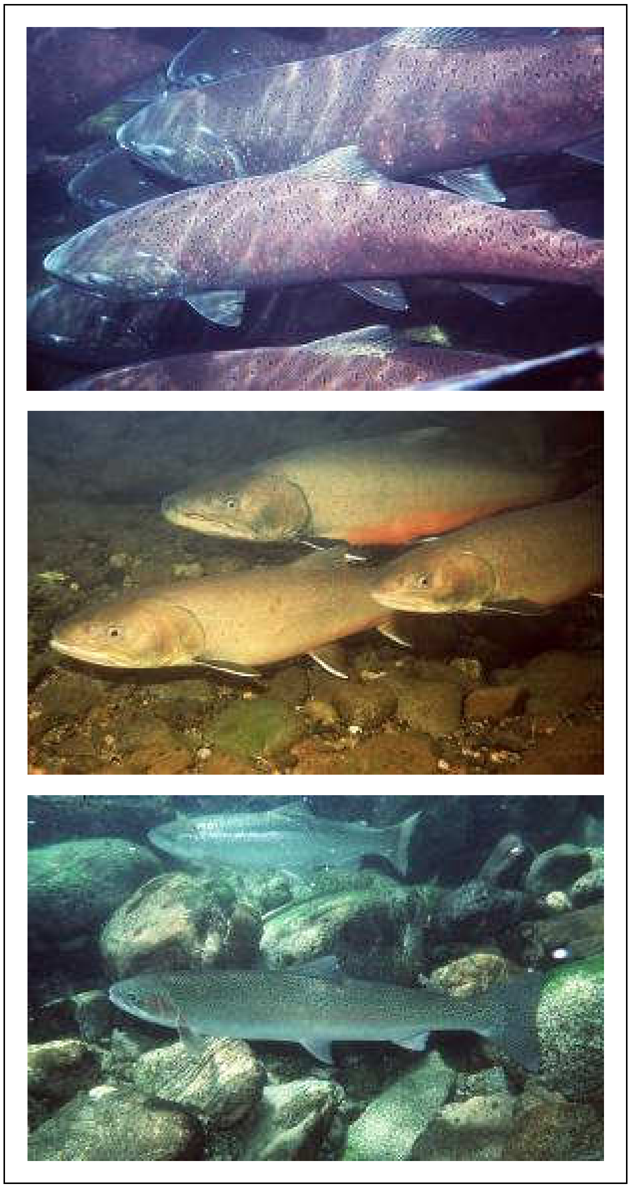

Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*

August 2007

Upper Columbia Salmon Recovery Board

*This Plan also covers bull trout, which are under the jurisdiction of the U.S. Fish and Wildlife Service. The strategies and actions in this proposed plan are intended as additional recommendations for the draft bull trout recovery plan that was published by the U.S. Fish and Wildlife Service in April 2002.

Coordination with United States Fish and Wildlife Service

Working closely with staff of National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries) and the U.S. Fish and Wildlife Service (USFWS), the Upper Columbia Salmon Recovery Board (UCSRB) developed this plan to support the recovery of spring Chinook salmon, steelhead, and bull trout listed under the Endangered Species Act. NOAA Fisheries has adopted this plan as its recovery plan for the Upper Columbia Spring Chinook and Upper Columbia Steelhead. The UCSRB recognizes that the USFWS listed the bull trout as a threatened species throughout its range in the lower 48 states, not just the portion of bull trout residing in the Upper Columbia area. The UCSRB therefore submits this plan to the USFWS as its recommendation for assisting in the recovery of bull trout in the Columbia River with the understanding that the USFWS will consider these recommendations in its recovery plan for the entire listed species.

Chinook salmon, bull trout, and steelhead photos used courtesy of Dr. Ernest R. Keeley, Idaho State University, Pocatello, Idaho.

Mission Statement:

To restore viable and sustainable populations of salmon, steelhead, and other at-risk species through collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia region.

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Acknowledgments

The development of this plan could not have been possible without the dedication and hard work of many people. This plan benefited greatly from the input by local citizens, local, state, and federal agencies, and tribes. Through the efforts by a core group of individuals and coordination with stakeholders, the following individuals and organizations contributed to the completion of this plan.

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Dick Nason was instrumental in coordinating staff and recovery activities. Denny Rohr contributed as board facilitator through the development of the recovery plan. Sandy Cox did a superb job in coordinating documents and meetings; her good nature was appreciated through the long meetings. Bob Bugert of the Governor’s Salmon Recovery Office provided guidance and enthusiastically contributed to the development of this plan. The look and readability of this plan was improved by the editing and document management skills of Laura Berg and her associates.

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Hosting Locations:

Douglas County Public Services Building
City of East Wenatchee, Council Chambers
Chelan County PUD Auditorium
Douglas County PUD Auditorium
Okanogan County PUD Auditorium
Okanogan County Board of County Commissioners Hearing Room
Chelan Fire Station District #7
North Central Washington RC&D Office
Chelan County Planning
City of Leavenworth

Dedication

While countless individuals have participated in the development of this plan, the late Esther Stefaniw, Chelan County Commissioner and one of the founding board members, played an instrumental role in rallying the region around locally led salmon recovery. In the spring of 1999, the first Upper Columbia Salmon Recovery Board meeting was held, and it was here that Esther made her famous proclamation, "If you think that you are a stakeholder, then you are!" She went so far as to bring her neighbors to board meetings so they could learn firsthand about local salmon recovery efforts. Her dedication and spirit brought the Board together and set it on a course for success. Esther demanded from us a commitment to the local process, at the individual citizen level, and never wavered from that ideal. Esther firmly believed that only through a grass-roots process would salmon recovery efforts realize their conservation and economic goals. The State of Washington commended Esther for her efforts to organize the Upper Columbia Salmon Recovery Board. It is the Board's sincere hope that we have furthered Esther's ideals and that this plan will be implemented for the good of people and fish in the Upper Columbia region.

The Board hereby dedicates this plan
to the memory and spirit
of our friend

Esther Stefaniw
Chelan County Commissioner (1996-2001)

Executive Summary

The Upper Columbia Salmon Recovery Board (UCSRB) developed this plan for the recovery of Upper Columbia spring Chinook (listed as ***endangered*** on March 24, 1999), Upper Columbia steelhead (listed as ***endangered*** on August 18, 1997; reclassified as ***threatened*** on January 5, 2006; and as a result of a legal challenge, reinstated to ***endangered*** status on June 13, 2007), and bull trout (the coterminous U.S. population was listed as ***threatened*** on November 1, 1999).

The mission for the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan developed by the Upper Columbia Salmon Recovery Board is:

> To restore viable and sustainable populations of salmon, steelhead, and other at-risk species through collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia region.

The Board intends to approach salmon recovery efforts in a transparent and evolving process to restore fish populations for ecosystems and people while enhancing the economic viability of the region.

This plan is an outgrowth and culmination of several conservation efforts in the Upper Columbia Basin, including current efforts related to the Endangered Species Act (ESA), state and tribal-sponsored recovery efforts, subbasin planning, and watershed planning.

Use of this Plan

This plan is to be used to guide federal agencies charged with species recovery. In and of itself, this plan is a non-regulatory document. As such, it is not intended to be nor may it serve as a regulatory document forcing landowner action. Any such regulatory actions deemed necessary as a result of this document must be accompanied by a clear legislative mandate to that end.

The plan may be used to inform state and local agency planning and land use actions, but it may not be deemed to place requirements on such entities. The goal of this plan is to offer options for future actions that strive to secure the survival of species. No mandate on state or local agencies may be construed from this plan, and the plan may not be cited as creating a need for new regulatory actions at the state or local level unless clear legislative authority is first adopted.

This plan is limited to address listed salmonid species. If any threatened or endangered species were introduced into an area where it has been designated as extirpated, this population would be treated as an experimental population under Section 10(j) or other mechanisms under ESA and would not increase ESA liabilities for landowners.

Regional Setting

This recovery plan is intended for implementation within the Upper Columbia River Basin, which includes the Columbia River and its tributaries upstream of the confluence of the Yakima River to the base of Chief Joseph Dam. The Upper Columbia Basin consists of six major "subbasins" (Crab, Wenatchee, Entiat, Lake Chelan, Methow, and Okanogan subbasins), several smaller watersheds, and the mainstem Columbia River. This area captures the distribution of Upper Columbia River spring Chinook, steelhead, and bull trout.

Currently, there are three independent populations of spring Chinook within the Upper Columbia Evolutionarily Significant Unit (Wenatchee, Entiat, and Methow) and five steelhead populations (Wenatchee, Entiat, Methow, Okanogan and Crab Creek populations) within the Upper Columbia steelhead Distinct Population Segment (DPS). Spring Chinook in the U.S. portion of the Okanogan subbasin have been extirpated, while Chinook in Canada have been proposed for endangered listing under the "Species at Risk Act." There are three "core" areas supporting bull trout populations (Wenatchee, Entiat, and Methow subbasins) and two areas designated as "unknown occupancy" (Lake Chelan and Okanogan subbasins) in the Upper Columbia Basin.

This plan emphasizes recovery of three spring Chinook populations (Wenatchee, Entiat, and Methow populations), four steelhead populations (Wenatchee, Entiat, Methow, and Okanogan populations), and recovery of bull trout within the Wenatchee, Entiat, and Methow subbasins.

Plan Development

The process of developing this plan began with identification of priority species—spring Chinook, steelhead, and bull trout—based on ESA listings and their population status (abundance, productivity, spatial structure, and diversity). Empirical information, when available, was used to determine current population status and threats. In cases where empirical information was lacking, derived data (from modeling), preliminary analysis, local knowledge or professional judgment (based on literature review or experience with similar conditions or factors) were used to identify threats. Limiting factors were then identified from the threats (both past and present).

Recovery objectives and criteria were identified by the Interior Columbia Basin Technical Recovery Team (ICBTRT) in collaboration with Upper Columbia technical committees. Categories of recovery actions were then recommended that addressed primary limiting factors within each sector (Harvest, Hatcheries, Hydro, and Habitat). In developing the plan it became clear that recovery objectives and criteria could not be met by implementing actions within only one sector (i.e., Habitat). Recovery of listed species requires implementation of actions within all sectors, including actions implemented outside the Upper Columbia Basin (e.g., within the lower Columbia River, estuary, and ocean).

Implementation of specific recovery actions will be coordinated with local stakeholders and jurisdictions that determine the feasibility of recommend actions, including socio-economic interests, benefits, and costs.

Current Status of Listed Populations

Spring Chinook

Spring Chinook begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook enter the Upper Columbia tributaries from April through July. After migration, they hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid to late August. Juvenile spring Chinook spend a year in freshwater before migrating to salt water in the spring of their second year of life. Most Upper Columbia spring Chinook return as adults after two or three years in the ocean. Some precocious males, or jacks, return after one winter at sea. A few other males mature sexually in freshwater without migrating to the sea. The run, however, is dominated by four- and five-year-old fish that have spent two and three years at sea, respectively. Fecundity ranges from 4,200 to 5,900 eggs, depending on the age and size of the female.

The risk of extinction over a 100-year period for spring Chinook within the Upper Columbia Basin was determined by following the guidance of the ICBTRT (2004, 2005). Risk of extinction was estimated for abundance/productivity and spatial structure/diversity.

Wenatchee Population

When considering the factors that determine diversity and spatial structure, the Wenatchee spring Chinook population is currently considered to be at a high risk of extinction because of the loss of naturally produced Chinook spawning in tributaries downstream from Tumwater Canyon. In addition, the Wenatchee spring Chinook population is currently not viable with respect to abundance and productivity and has a greater than 25% chance of extinction in 100 years. In sum, the Wenatchee spring Chinook population is not currently viable and has a high risk of extinction.

Entiat Population

When considering the factors that determine diversity and spatial structure, the Entiat spring Chinook population is currently considered to be at high risk. The Entiat spring Chinook population is currently not viable with respect to abundance and productivity and has a greater than 25% chance of extinction in 100 years. In sum, the Entiat spring Chinook population is not currently viable and has a high risk of extinction.

Methow Population

When considering the factors that determine diversity and spatial structure, the Methow spring Chinook population is currently considered to be at a high risk of extinction. Based on abundance and productivity, the Methow spring Chinook population is not viable and has a greater than 25% chance of extinction in 100 years. In sum, the Methow spring Chinook population is not currently viable and has a high risk of extinction.

Okanogan Population

Spring Chinook in the Okanogan subbasin are currently extinct. The Colville Tribes are working to reintroduce spring Chinook into the subbasin. This population would be treated as an experimental population under ESA Section 10(j) or other mechanisms under ESA that would not increase ESA liabilities to landowners.

Steelhead

The life-history pattern of steelhead in the Upper Columbia Basin is complex. Adults return to the Columbia River in the late summer and early fall. Unlike spring Chinook, most steelhead do not move upstream quickly to tributary spawning streams. A portion of the returning run overwinters in the mainstem reservoirs, passing over the Upper Columbia River dams in April and May of the following year. Spawning occurs in late spring of the calendar year following entry into the river. Currently, and for the past 20+ years, most steelhead spawning in the wild are hatchery fish. The effectiveness of hatchery fish spawning in the wild compared to naturally produced spawners is unknown at this time and may be a major factor in reducing steelhead productivity.

Juvenile steelhead generally spend one to three years rearing in freshwater before migrating to the ocean, but can spend as many as seven years in freshwater before migrating. Most adult steelhead return to the Upper Columbia after one or two years at sea. Steelhead in the Upper Columbia have a relatively high fecundity, averaging between 5,300 and 6,000 eggs.

Steelhead can residualize (lose the ability to smolt) in tributaries and never migrate to sea, thereby becoming resident rainbow trout. Conversely, progeny of resident rainbow trout can migrate to the sea and thereby become steelhead. Despite the apparent reproductive exchange between resident and anadromous ***O. mykiss***, the two life forms remain separated physically, physiologically, ecologically, and behaviorally (70 FR 67130). Given this separation, NMFS (70 FR 67130) proposed that the anadromous steelhead populations are discrete from the resident rainbow trout populations. Therefore, this plan only addresses the recovery of anadromous steelhead. Resident rainbow trout are not included in the recovery of steelhead.

The risk of extinction over a 100-year period for steelhead within the Upper Columbia Basin was determined by following the guidance of the ICBTRT (2004b, 2005a). Risk of extinction was estimated for abundance/productivity and spatial structure/diversity.

Wenatchee Population

When considering the factors that determine diversity and spatial structure, the Wenatchee steelhead population is currently considered to be at a high risk of extinction. Based only on abundance and productivity, the naturally produced Wenatchee steelhead population is not viable and has a greater than 25% chance of extinction in 100 years. In sum, the Wenatchee steelhead population is not currently viable and has a moderate to high risk of extinction.

Entiat Population

When considering the factors that determine diversity and spatial structure, the Entiat steelhead population is currently considered to be at a high risk of extinction. Based only on abundance and productivity, the Entiat steelhead population is not viable and has a greater than 25% chance of extinction in 100 years. In sum, the Entiat steelhead population is not currently viable and has a moderate to high risk of extinction.

Methow Population

When considering the factors that determine diversity and spatial structure, the Methow steelhead population is currently considered to be at a high risk of extinction. Based only on abundance and productivity, the Methow steelhead population is not viable and has a greater than 25% chance of extinction in 100 years. In sum, the Methow steelhead population is not currently viable and has a moderate to high risk of extinction.

Okanogan Population

When considering the factors that determine diversity and spatial structure, the Okanogan steelhead population is currently considered to be at a high risk of extinction. Based on abundance and productivity, the Okanogan steelhead population is not viable and has a greater than 25% chance of extinction in 100 years. In sum, the Okanogan steelhead population is not currently viable and has a high risk of extinction.

Bull Trout

Bull trout in the Upper Columbia Basin exhibit both resident and migratory life-history strategies. Resident bull trout complete their entire life cycle in the tributary stream in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form) or river (fluvial form). Migrating bull trout have been observed within spawning tributaries as early as the end of June, while spawning occurs in mid-September to late October/early November. Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior.

The size and age of bull trout at maturity depends upon life-history strategy. Resident fish tend to be smaller than migratory fish at maturity and produce fewer eggs. Bull trout usually reach sexual maturity in four to seven years and may live longer than 12 years. Bull trout spawn in the fall typically in cold, clean, low-gradient streams with loose, clean gravel. Bull trout at all life stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools.

The U.S. Fish and Wildlife Service has not developed guidance for estimating risk of extinction of Upper Columbia bull trout. Therefore, what follows is a summary of the current status of bull trout without a determination of extinction risk.

Wenatchee Core Area

Abundance and productivity of bull trout in the Wenatchee subbasin is based on redd surveys. However, redd survey procedures have changed over time and different streams have different survey periods. Surveys from 2000-2004 were conducted consistently across all populations and redd counts during this period ranged from 309 to 607 in the core area.

For streams with long-term redd counts, numbers of redds have increased over time (e.g., Chiwawa basin). However, there is a fair amount of variability in all the other populations. Number of redds for Little Wenatchee, Nason Creek, Ingalls Creek, and Chiwaukum Creek are very low. Although both migratory and multiple size classes of resident bull trout are present in upper Icicle Creek, spawning areas are currently unknown. No bull trout redd surveys have been conducted in Icicle Creek.

Bull trout currently occur in the Chiwawa River, White River, Little Wenatchee River, Nason Creek, Chiwaukum Creek, Icicle Creek, Peshastin Creek, Negro Creek, and Ingalls Creek drainages. Adfluvial, fluvial, and resident forms of bull trout exist in the Wenatchee subbasin.

Entiat Core Area

Numbers of bull trout redds in the Entiat subbasin have ranged from 10 to 52 redds in the Mad River and 0 to 46 redds in the Entiat River. A large increase in numbers of redds counted in the Entiat River in 2004 resulted from increasing the survey area and changes in survey effort.

Numbers of bull trout redds in the Entiat subbasin have increased since they were first counted in 1989, suggesting an increasing trend in production.

Bull trout occur in both the Mad and Entiat rivers. It is assumed that most of the bull trout in the Entiat subbasin are fluvial fish, with perhaps a resident form in the upper reaches of the Mad

River drainage. Bull trout have been observed in Tillicum and Stormy creeks. Recent studies suggest that bull trout from this core area use the mainstem Columbia River for overwintering habitat and foraging.

Methow Core Area

Bull trout redd surveys in the Methow subbasin began in the early 1990s. Total numbers of redds within the subbasin have ranged from 4 to 195 redds. However, these are not valid estimates of abundance, because not all bull trout spawning streams were surveyed annually, lengths of surveys reaches have changed within a given stream, and survey methods have changed over time. Based on more recent surveys (2000-2004), when survey methods were more similar, redd counts ranged from 127 to 195.

Numbers of redds counted in the Methow subbasin appear to have increased since the mid-1990s. However, this trend is an artifact of changing survey methods. Looking at recent years (2000-2004), when survey methods were similar, there was a fairly stable number of redds ranging from 147 in 2000 to 148 in 2004. Currently, there is insufficient data to establish a trend for the entire core area. In the Twisp and the Upper Methow areas, redd counts are highly variable, but reveal a decreasing trend since 2000.

Currently bull trout occur within the Twisp River, Chewuch River, Lake Creek, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, Beaver Creek, Gold Creek and Libby Creek, and Goat Creek drainages. Bull trout exist upstream of the anadromous fish barrier on Early Winters Creek, Wolf Creek, Beaver Creek, and the Lost River. The population structure of the Lost River is unknown, but likely contributes to the genetic diversity of the Methow core population. Resident, fluvial, and adfluvial forms still occur in the Methow subbasin.

Limiting Factors and Threats

Some human activities acting in concert with natural occurrences (e.g., drought, floods, landslides, fires, debris flows, and ocean cycles) have impacted the abundance, productivity, spatial structure, and diversity of Upper Columbia spring Chinook salmon, steelhead, and bull trout populations, resulting in these species being listed under the ESA. Coho salmon and some populations of spring Chinook and bull trout have been lost from the region. Lasting effects from some of these early activities may still act to limit fish production in the Upper Columbia Basin. Threats from some current activities are also present in the Upper Columbia Basin.

Populations of spring Chinook and steelhead within the Upper Columbia River Basin were first affected by the intensive commercial fisheries in the lower Columbia River. These fisheries began in the latter half of the 1800s and continued into the 1900s and nearly eliminated many salmon and steelhead stocks. With time, the construction of dams and diversions, some without passage, blocked salmon and steelhead migrations, isolated or fragmented bull trout populations, and killed upstream and downstream migrating fish. Early hatcheries constructed to mitigate for fish loss at dams and loss of spawning and rearing habitat were operated without a clear understanding of population genetics, where fish were transferred without consideration of their actual origin. Although hatcheries were increasing the abundance of stocks, they were probably also decreasing the diversity and productivity of populations they intended to supplement.

Concurrent with these historic activities, human population growth within the basin was increasing and land uses, in many cases encouraged and supported by governmental policy, were in some areas impacting salmon and trout spawning and rearing habitat. In addition, non-native species were introduced by both public and private interests throughout the region that directly or indirectly affected salmon and trout. These activities acting in concert with natural disturbances decreased the abundance, productivity, spatial structure, and diversity of Chinook salmon, steelhead, and bull trout in the Upper Columbia Basin.

Presently, harvest has been greatly reduced from historic levels, dams are being changed and operated in ways that increase passage and reservoir survival, hatcheries are in some cases being managed to address spatial structure and diversity issues, and habitat degradation is being reduced by implementation of recovery projects, voluntary efforts of private landowners, irrigators, and local governments, and improved land management practices on public and private lands. Nevertheless, additional actions are needed within all sectors (Harvest, Hatchery, Hydro, and Habitat) in order for listed stocks in the Upper Columbia Basin to recover.

There are a number of threats that may continue to limit the recovery of ESA-listed fish species in the Upper Columbia Basin. These threats can be organized according to the five categories as set forth in Section 4(a)(1) of the ESA and all apply to this recovery plan:

- The present or threatened destruction, modification, or curtailment of its habitat or range.
- Overutilization for commercial, recreational, scientific, or educational purposes.
- Disease or predation.
- Inadequacy of existing regulatory mechanisms.
- Other natural or human-made factors affecting its continued existence.
- Current threats include:
- The following threats were identified in the Federal Register Rules and Regulation at the time the species were listed. Actions identified within this plan address these threats.

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, some aspects of agriculture (including livestock grazing) residential development, and some historic forest management continue to threaten spring Chinook, steelhead, and bull trout and their habitat in some locations in the Upper Columbia Basin.
- Water diversions without proper passage routes disrupt migrations of listed fish species.
- Unscreened diversions trap or divert juvenile spring Chinook, steelhead, and bull trout resulting in reduced survival.
- Hydroelectric passage mortality reduces abundance of migrant spring Chinook, steelhead, and bull trout.
- Sedimentation from land and water management activities is a cause of habitat degradation in some salmon and trout streams.

- Loss of habitat complexity, off-channel habitat, and large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large woody debris reduces survival of listed fish species and threatens their habitat in some locations in the Upper Columbia Basin.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- The effects of incidental mortality on naturally produced spring Chinook, steelhead, and bull trout may increase during recreational fishing for hatchery fish or other species.
- Harvest of bull trout because of misidentification continues under existing fishing regulations.
- Incidental harvest mortality in mixed-stock and commercial fisheries contributes to the loss of naturally produced spring Chinook and steelhead.
- Illegal harvest (poaching) continues to threaten listed fish species.

Disease or Predation

- The presence of non-native species has resulted in increased predator populations that prey on listed fish species and/or compete with listed fish.
- Increased predation by northern pikeminnow affects the survival of downstream migrating spring Chinook, steelhead, and bull trout.
- Predation by pinnipeds (marine mammals) and birds are also a threat to spring Chinook and steelhead.

Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.
- Although the Washington State Growth Management Act and Shoreline Management Act have been significantly changed to improve management, conditions and protection efforts for listed species and compliance monitoring (enforcement) have lagged behind because of a lack of political support and funding.
- The extent and distribution of Federal lands limits the ability of the Northwest Forest Plan and PACFISH/INFISH to achieve its aquatic habitat restoration objectives at watershed and river basin scales.
- The “base” State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of listed fish species.
- The Federal Clean Water Act has not been completely implemented and therefore has not been completely successful in protecting listed fish species, particularly with respect to non-point sources of pollution.

Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural conditions (e.g., fires, floods, droughts, landslides, etc.) can exacerbate the problems associated with degraded and altered aquatic habitats.
- Drought conditions reduce already limited spawning, rearing, and migration habitat.
- Poor ocean conditions (e.g., less upwelling, warm surface waters, etc.) negatively affect spring Chinook and steelhead production.
- The use of non-locally derived broodstock for hatchery programs may negatively affect genetic integrity.
- Introduction of brook trout threatens bull trout through hybridization, competition, and predation.
- The collection of naturally produced spring Chinook and steelhead for hatchery broodstock may harm small or dwindling natural populations if not done with caution.
- Competition, genetic introgression, and disease transmission resulting from hatchery introductions may reduce the productivity and survival of naturally produced spring Chinook and steelhead.

Recovery Goals

Recovery requires reducing or eliminating threats to the long-term persistence of fish populations, maintaining widely distributed and connected fish populations across diverse habitats of their native ranges, and preserving genetic diversity and life-history characteristics. To be consistent with the vision and goals of this plan, listed populations must meet specific ***abundance***, ***productivity***, ***spatial structure***, and ***diversity*** objectives and criteria. This plan refers to these parameters as the four “viable salmonid population” (VSP) parameters.

Because listed anadromous fish species and bull trout have different life-history characteristics, this plan recommends different recovery goals for the different species. The specific goal for spring Chinook and steelhead is:

- **To secure long-term persistence of viable populations of naturally produced spring Chinook and steelhead distributed across their native range.**

Recovery of the Upper Columbia spring Chinook ESU will require the recovery of the Wenatchee, Entiat, and Methow populations. Recovery of the Upper Columbia steelhead DPS will require the recovery of the Wenatchee, Entiat, Methow, and Okanogan populations, but not the Crab Creek population. This plan deviates from the most recent recommendation of the ICBTRT (December 2005) that at least two populations within the ESU and DPS must meet abundance/productivity criteria that represent a 1% extinction risk over a 100-year period. This plan requires that all populations within the spring Chinook ESU and the steelhead DPS (save the Crab Creek steelhead population) meet abundance/productivity criteria that represent 5% extinction risk over a 100-year period.

The specific goal for bull trout is:

- **To secure long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed across the native range of the species.**

This plan recognizes the importance of providing valid metrics for tributary productivity. It is the policy of the UCSRB to emphasize juvenile salmonid productivity within each tributary as the primary indicator of habitat restoration success for each basin in the Upper Columbia. This will be accomplished primarily by evaluating "smolts per spawner" and/or "smolts per redd." Although this plan does not identify specific recovery criteria based on these factors, this will allow a consistent approach to evaluate the level of success for restoration and recovery actions in the Upper Columbia and the quality of habitat in tributaries.

Recovery Objectives

Because spring Chinook and steelhead are currently listed as ***endangered*** under the ESA, this plan identifies two levels of objectives for them. The first identifies objectives related to reclassifying the species as ***threatened*** and the second relate to recovery (delisting).

Spring Chinook and Steelhead Reclassification Objectives

- Increase the abundance and productivity of naturally produced spring Chinook and steelhead within each population in the Upper Columbia ESU to levels that would lead to reclassification of the ESU and DPS as threatened under the ESA.

- Increase the current distribution of naturally produced spring Chinook and steelhead in the Upper Columbia ESU and DPS and conserve genetic and phenotypic diversity.

Spring Chinook and Steelhead Recovery Objectives

- Increase the abundance of naturally produced spring Chinook and steelhead spawners within each population in the Upper Columbia ESU and DPS to levels considered viable.

- Increase the productivity (spawner:spawner ratios and smolts/redds) of naturally produced spring Chinook and steelhead within each population to levels that result in low risk of extinction.

- Restore the distribution of naturally produced spring Chinook and steelhead to previously occupied areas where practical and allow natural patterns of genetic and phenotypic diversity to be expressed.

Bull trout in the Upper Columbia Basin are currently listed as ***threatened*** under the ESA. Therefore this plan only identifies recovery objectives. It is important to note that core populations within the Upper Columbia Basin make up only a portion of the total Columbia Basin population. Therefore, even if the core populations within the Upper Columbia meet recovery objectives and criteria, the population may not be de-listed if other core populations throughout the Columbia Basin do not meet their objectives and criteria.

Bull Trout Recovery Objectives

- Increase the abundance of adult bull trout within each core population in the Upper Columbia Basin to levels that are considered self sustaining.

- Maintain stable or increasing trends in abundance of adult bull trout within each core population in the Upper Columbia River Basin.
- Maintain the current distribution of bull trout in all local populations, restore distribution to previously occupied areas where practical, maintain and restore the migratory form and connectivity within and among each core area, conserve genetic diversity, and provide for genetic exchange.

Recovery Criteria

The following criteria developed for recovery of naturally produced spring Chinook, steelhead, and bull trout address quantitative and qualitative measurements of abundance, productivity, spatial structure, and diversity on a population or core population basis.

Spring Chinook Reclassification Criteria

- Abundance and productivity (based on 8-year geometric mean) of naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations must reach levels that would have less than a 10% risk of extinction over a 100-year period.
- Processes affecting spatial structure must result in at least a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all factors considered "high" risk would have been addressed.
- Processes affecting diversity will result in at least a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all factors considered "high" risk would have been addressed.

Spring Chinook Recovery Criteria

- Abundance and productivity (based on 12-year geometric mean) of naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations must reach levels that would have less than a 5% risk of extinction over a 100-year period.
- At a minimum, the Upper Columbia Spring Chinook ESU will have a productivity greater than 1.0 and maintain at least 4,500 naturally produced spawners distributed among the three populations as follows:

Population	Abundance	Productivity (Spawner:Spawner)
Wenatchee	2,000	1.2
Entiat	500	1.4
Methow	2,000	1.2

- Over a 12-year period, naturally produced spring Chinook will use currently occupied spawning areas throughout the ESU according to the following population-specific criteria:

Wenatchee

Naturally produced spring Chinook spawning will occur within four of the five major spawning areas in the Wenatchee subbasin (Chiwawa River, White River, Nason Creek, Little Wenatchee River, or Wenatchee River) and within one minor spawning area downstream from Tumwater Canyon (Chumstick Creek, Peshastin Creek, Icicle Creek, or Mission Creek). The minimum number of naturally produced spring Chinook redds within each major spawning area will be either 5% of the total number of redds within the Wenatchee subbasin or at least 20 redds within each major area, whichever is greater.

Entiat

Naturally produced spring Chinook will spawn within the one major spawning area within the Entiat subbasin.

Methow

Naturally produced spring Chinook spawning will occur within the Twisp, Chewuch, and Upper Methow major spawning areas. The minimum number of naturally produced spring Chinook redds within each major spawning area will be either 5% of the total number of redds within the Methow subbasin or at least 20 redds within each major area, whichever is greater.

- Processes affecting spatial structure will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all factors considered “high” risk would have been addressed.

- Processes affecting diversity will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all factors considered “high” risk would have been addressed.

Steelhead Reclassification Criteria

- Abundance and productivity (based on 8-year geometric mean) of naturally produced steelhead with in the Wenatchee, Entiat, Methow, and Okanogan populations must reach levels that would have less than a 10% risk of extinction over a 100-year period.

- Processes affecting spatial structure must result in at least a **moderate** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered “high” risk will have been addressed.

- Processes affecting diversity will result in at least a **moderate** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered “high” risk will have been addressed.

Steelhead Recovery Criteria

- Abundance and productivity (based on 12-year geometric mean) of naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations must reach levels that would have less than a 5% risk of extinction over a 100-year period.

- At a minimum, the Upper Columbia Steelhead DPS will have a productivity greater than 1.0 and maintain at least 3,000 spawners distributed among the four populations as follows:

Population	Abundance	Productivity (Spawner:Spawner)
Wenatchee	1,000	1.1
Entiat	500	1.2
Methow	1,000	1.1
Okanogan	500[1]	1.2

- Over a 12-year period, naturally produced steelhead will use currently occupied spawning areas throughout the DPS according to the following population-specific criteria:

Wenatchee

Naturally produced steelhead spawning will occur within four of the five major spawning areas in the Wenatchee Subbasin (Chiwawa River, Nason Creek, Icicle Creek, Peshastin Creek, or Chumstick Creek). The minimum number of naturally produced steelhead redds within four of the five major spawning areas will be either 5% of the total number of redds within the Wenatchee population or at least 20 redds within four of the five major areas, whichever is greater.

Entiat

Naturally produced steelhead will spawn within the two major spawning areas within the Entiat subbasin (Middle Entiat and Mad rivers). The minimum number of naturally produced steelhead redds within the two major spawning areas will be either 5% of the total number of redds within the Entiat population or at least 20 redds within major areas, whichever is greater.

Methow

Naturally produced steelhead spawning will occur within three of the four major spawning areas (Twisp, Chewuch, Beaver, or Upper Methow). The minimum number of naturally produced steelhead redds within each major spawning area will be either 5% of the total number of redds within the Methow subbasin or at least 20 redds within each major area, whichever is greater.

Okanogan

Steelhead spawning will occur within the two major spawning areas (Salmon and Omak Creeks) and within at least two of the five minor spawning areas (Ninemile, Whitestone, Bonaparte, Antoine, or Loup Loup). The minimum number of naturally produced

[1] The Interior Columbia Basin Technical Recovery Team has determined that 500 naturally produced steelhead adults will meet the minimum abundance recovery criteria within the U.S. portion of the Okanogan subbasin. If the Canadian portion of the Okanogan subbasin is included, the minimum abundance recovery criteria would be 1,000 naturally produced steelhead adults.

steelhead redds within the major spawning areas will be either 5% of the total number of redds within the Okanogan subbasin or at least 20 redds within each area, whichever is greater.

- Processes affecting spatial structure will result in a ***moderate*** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered "high" risk would have been addressed.
- Processes affecting diversity will result in a ***moderate*** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered "high" risk would have been addressed.

Bull Trout Recovery Criteria

- The abundance of Upper Columbia bull trout will increase and maintain a 12-year geometric mean of 4,144-5,402 spawners, distributed among the three core areas as follows:

Population	Abundance
Wenatchee	1,612-2,257
Entiat	298-417
Methow	1,234-1,728[2]

- The trend in numbers of bull trout redds (an index of numbers of spawners) within each population in the core areas (Wenatchee, Entiat, and Methow) is stable or increasing over a 12-year period.
- Bull trout will use spawning areas throughout the Upper Columbia Basin according to the following population-specific criteria:

Wenatchee

Bull trout spawning will occur within the seven interconnected areas (Chiwawa, White, Little Wenatchee, Nason, Icicle, Chiwaukum, and Peshastin), with 100 or more adults spawning annually within three to five areas.

Entiat

Bull trout spawning will occur within the two interconnected areas (Entiat and Mad), with 100 or more adults spawning annually in both areas.

Methow

Bull trout spawning will occur within the ten interconnected areas (Gold, Twisp, Beaver, Chewuch, Lake Creek, Wolf, Early Winters, Upper Methow, Goat, and Lost), with 100 or more adults spawning annually within three to four areas.

- The migratory form of bull trout and connectivity within and among core areas must be present.

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[2] This criterion does not include bull trout in the Lost River drainage.

Strategy for Recovery

This plan recommends recovery actions for all sectors (Harvest, Hatchery, Hydro, and Habitat) that affect populations of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Several ongoing processes, including the redevelopment of the biological opinion for the Federal Columbia River Power System (FCRPS) and ***U.S. v. Oregon***, are expected to produce new or amended strategies and actions. Some of the recovery actions recommended in this plan were developed in other forums or processes (e.g., Public Utility District Habitat Conservation Plans) and are incorporated with little or no modification. Several have already been implemented to the benefit of one or more of the viable salmonid population parameters (abundance, productivity, spatial structure, and diversity) of populations in the Upper Columbia Basin.

Identified in this plan are **306** recovery actions to be implemented within the Upper Columbia Basin. By sector, there are 87 harvest actions, 50 hatchery actions, 16 hydro project actions, and 153 habitat actions. In addition, there are **188** monitoring and research actions, which, when broken down by sector is 55 harvest actions, 76 hatchery actions, 8 hydro project actions, and 49 habitat actions. One or more actions are associated with each of the following objectives within each sector.

All the recommended recovery objectives and actions identified in this plan may be modified in response to monitoring, research, and adaptive management and as determinations made in other processes such as the FCRPS Biological Opinion, ***U.S. v Oregon***, and hatchery reform programs. Any modification, especially those that change the regulatory environment or impose additional costs or restrictions on private property and water rights, shall be submitted for public review and comment by local governments and stakeholders, and approved by the UCSRB before implementation.

Harvest

Harvest objectives for treaty and non-treaty salmon and steelhead fisheries in the Columbia River Basin are set by the applicable state, tribal, and federal agencies. Fishery objectives from McNary Dam to the mouth of the Columbia River (fishing zones 1-6) are established by state, tribal, and federal parties in ***U.S. v Oregon***. In developing management plans under ***U.S. v Oregon***, the parties recognize the necessity of managing the fisheries to provide spawning escapement to the various tributary production areas, including the Upper Columbia tributaries covered in this plan. At the same time, they seek to provide meaningful treaty and non-treaty fishing opportunities in zones 1-6, targeting the more productive natural and hatchery stocks, and, where possible, allow fish to pass through to provide tributary fishing opportunities.

The following objectives for harvest apply not only to the Upper Columbia Basin, but also include the entire Columbia River. This plan will strengthen the likelihood that all actions and mitigation associated with harvest throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout. These objectives are intended to reduce threats associated with harvest.

Short-Term Objectives

- Use selective harvest techniques to constrain harvest on naturally produced fish at the currently reduced rates in the Upper Columbia Basin.

- Use selective harvest techniques to preserve fishery opportunities in the Upper Columbia Basin that focus on hatchery produced fish that are not needed for recovery.
- Recommend that parties of ***U.S. v Oregon*** incorporate Upper Columbia viable salmonid population criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.
- Increase effective enforcement of fishery rules and regulations.
- Appropriate co-managers/fisheries management agencies should work with local stakeholders to develop tributary fisheries management goals and plans.

Long-Term Objectives

- Provide opportunities for increased tributary harvest consistent with recovery.
- Incorporate Upper Columbia viable salmonid population criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.

Research and Monitoring Objectives

- Research and employ best available technology to reduce incidental mortality of non-target fish in selective fisheries.
- Monitor the effects of incidental take on naturally produced populations in the Upper Columbia Basin.
- Improve estimates of harvested fish and indirect harvest mortalities in freshwater and ocean fisheries.
- Initiate or continue monitoring and research to improve management information, such as the timing of the various run components through the major fisheries.

This plan balances these harvest objectives with the federal government's trust obligations to Native Americans and integrates efforts from the following harvest programs: Pacific Fishery Management Council, the Pacific Salmon Commission, and the Columbia River mainstem and tributary fisheries.

Hatcheries

This plan recognizes that hatchery strategies and actions have been reviewed and considered in several ongoing processes. The following objectives for hatchery programs apply to both federal and state-operated facilities in the Upper Columbia Basin and are intended to be consistent with these ongoing processes. The identified objectives are intended to be consistent with other plans and should reduce the threats associated with hatchery production in the Upper Columbia Basin while meeting other obligations. Actions and mitigation associated with hatcheries throughout the Upper Columbia River Basin should not preclude the recovery of Upper Columbia spring Chinook, steelhead, and bull trout. Additionally, future hatchery facilities will support recovery goals, and minimize and mitigate any impacts (including objectives within other sectors).

Short-Term Objectives

- Continue to use artificial production to maintain critically depressed populations in a manner that is consistent with recovery and avoids extinction.
- Use artificial production to seed unused, accessible habitats.
- Use artificial production to provide for tribal and non-tribal fishery obligations as consistent with recovery criteria.
- Use harvest or other methods to reduce the proportion of hatchery-produced fish in naturally spawning populations.
- To the extent possible use local broodstocks in hatchery programs.
- To the extent possible, integrate federal, state, and tribal-operated hatchery programs that use locally derived stocks.[3]

Long-Term Objectives

- Phase out the use of out-of-basin stock in the federal programs at Leavenworth and Entiat National Fish Hatcheries if continued research indicates that the programs threaten recovery of listed fish and those threats cannot be minimized through operational or other changes.
- Strive to make ongoing hatchery programs consistent with recovery.
- Provide for tribal and non-tribal fishery obligations.
- Use harvest or other methods to reduce the proportion of hatchery produced fish in naturally spawning populations.
- Manage hatcheries to achieve sufficient natural productivity and diversity to de-list populations and to avert re-listing of populations.

Research and Monitoring Objectives

- Employ the best available technology to monitor the effects of hatchery releases on natural populations and production.
- Develop marking programs to assure that hatchery produced fish are identifiable for harvest management, escapement goals, and reproductive success studies.
- Evaluate existing programs and redesign as necessary so that artificial production does not pose a threat to recovery.
- Integrate and coordinate monitoring activities between federal, state, and tribal programs.

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[3] Because state and federal hatchery programs have different objectives and obligations, the programs cannot be fully integrated. However, they can develop common broodstock protocols and production levels that optimize recovery of naturally produced fish.

- Examine the reproductive success of naturally and hatchery produced spring Chinook and steelhead spawning in the wild.
- Examine steelhead kelt reconditioning and their reproductive success.
- Continue studies to assess the effects of the coho reintroduction program.
- Examine the interactions (competition and predation) between naturally and hatchery produced steelhead.
- Continue to examine residualism of hatchery produced steelhead.
- Examine the feasibility of reintroducing bull trout (including ESA status of introduced stock) into the Chelan and Okanogan subbasins.
- Examine the feasibility (including ESA status of introduced stock) of reintroducing spring Chinook into the Okanogan subbasin.

This plan recognizes the need to balance hatchery recovery objectives with legal obligations and mandates under Habitat Conservation Plans, the Mitchell Act, federal government and tribal agreements, Hatchery and Genetic Management Plans, ***U.S. v. Oregon,*** and relicensing agreements.

Hydro Projects

Upper Columbia ESU and DPS migrate through four federally owned projects and three to five projects owned by public utility districts (PUDs). The four federally owned projects include McNary, John Day, The Dalles, and Bonneville dams, power plants, and reservoirs in the lower Columbia River. These projects are part of the FCRPS. Projects owned and operated by public utility districts include Wells (Douglas County PUD), Rocky Reach and Rock Island (Chelan County PUD), and Wanapum and Priest Rapids dams (Grant County PUD). These projects are licensed by the Federal Energy Regulatory Commission.

This plan recognizes that hydro strategies and actions have been reviewed and considered in several ongoing processes, including FCRPS Section 7 consultations (for the lower four federal dams on the Columbia River). The following objectives are intended to be consistent with these processes; however, they apply primarily to the projects owned by the PUDs. These objectives are consistent with the Anadromous Fish Agreement and Habitat Conservation Plans (HCPs), Priest Rapids Salmon and Steelhead Settlement Agreement, and Section 7 Consultations. This plan strengthens the likelihood that all actions and mitigation associated with hydro projects throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout. These objectives are intended to reduce the threats associated with hydroelectric development in the Upper Columbia Basin.

Short-Term Objectives

- Continue the actions identified in the Anadromous Fish Agreement and HCPs that will achieve no net impact for Upper Columbia steelhead and spring Chinook.
- Implement the actions identified in the Settlement Agreement and Section 7 Consultation with Grant PUD that will improve spring Chinook and steelhead survival.

- Implement the actions identified in the U.S. Fish and Wildlife Service biological/conferencing opinion with Douglas and Chelan PUDs that will improve conditions for Upper Columbia bull trout.
- Implement the actions identified in the Lake Chelan Hydroelectric Project relicensing agreement that will provide suitable spawning habitat for steelhead in the tailrace and lower Chelan River (downstream from the natural fish barriers).
- Strive to build hydroelectric dams proposed for construction in the future in the Upper Columbia Basin that have no negative effect on spring Chinook, steelhead, and bull trout viable salmonid population parameters.
- Encourage the implementation of actions for federal hydroelectric projects identified in the remanded Federal Columbia River Power System biological opinion.

Long-Term Objectives

- Provide upstream and downstream passage for juvenile/smolt and adult life stages.
- Implement the actions identified in the Lake Chelan Comprehensive Fishery Management Plan to determine the feasibility and possible reintroduction of bull trout into the basin.
- Achieve no-net-impact on species covered under the Anadromous Fish Agreement, HCPs, and Section 7 Consultations.
- Maintain suitable subadult and adult bull trout rearing and passage conditions in the mainstem Upper Columbia River.
- Maintain suitable spawning habitat for steelhead in the lower Chelan River and tailrace.

Research and Monitoring Objectives

- Determine baseline survival estimates for juvenile spring Chinook, steelhead, and bull trout as they pass hydroelectric projects on the Upper Columbia River.
- Evaluate effects of hydroelectric projects on adult passage of spring Chinook, steelhead, and bull trout.
- Evaluate if passage through hydroelectric projects affect spawning success or fitness of spring Chinook, steelhead, and bull trout.
- Evaluate effectiveness of predator control programs.

Most of these objectives are consistent with the legal mandates of the HCPs, Section 7 Consultations, and relicensing agreements. The primary objective of the HCPs is to achieve no-net-impact. If met, this objective would equate to a net productivity equivalent to the productivity that could be attained if these projects did not exist. The HCPs intend to meet no-net-impact primarily through mainstem survival objectives for juvenile and adult salmonids, and through off-site mitigation with hatchery and tributary habitat improvements. The goal is to achieve combined adult and juvenile survival of 91% per project. The remaining 9% will be compensated through hatchery (7%) and tributary (2%) activities.

Habitat

The following objectives for habitat restoration apply to all streams that currently support or may support (in a restored condition) spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. These objectives are consistent with subbasin plans, watershed plans, the Upper Columbia Biological Strategy, Habitat Conservation Plans, and relicensing agreements, and are intended to reduce threats to the habitat needs of the listed species. Because maintaining existing water rights are important to the economy of landowners within the Upper Columbia Basin, this plan will not ask individuals or organizations to affect their water rights without empirical evidence as to the need for the recovery of listed species. To the extent allowed by law, landowners will be adequately compensated for implementing recovery actions. In addition, any land acquisition proposal in this plan will be based on the concept of no net loss of private property ownership, such as conservation easements, transfer of development rights, and other innovative approaches. This plan will strengthen the likelihood that all actions and mitigation associated with habitat throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout. These objectives will be implemented within natural, social, and economic constraints. Local habitat groups (in cooperation with local landowners) will prioritize and coordinate the implementation of "specific" habitat actions within specific stream areas.

Short-Term Objectives

- Protect[4] existing areas where high ecological integrity and natural ecosystem processes persist.
- Restore connectivity (access) throughout the historic range where feasible and practical for each listed species.
- Where appropriate, establish, restore, and protect stream flows (within the natural hydrologic regime and existing water rights) suitable for spawning, rearing, and migration (based on current research and modeling).
- Protect and restore water quality where feasible and practical within natural constraints.
- Increase habitat diversity in the short term by adding instream structures (e.g., large woody debris, rocks, etc.) where appropriate.[5]
- Protect and restore riparian habitat along spawning and rearing streams and identify long-term opportunities for riparian habitat enhancement.

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[4] Protect or protection in this plan refers to ***all*** actions that safeguard required habitat features of listed species. This plan does not recommend land acquisition, unless "no net loss" of the tax base of the county in which the land is being sold is accomplished.

[5] This plan recommends the use of instream structures (such as boulders and LWD) as an immediate, short-term action to increase habitat diversity. These structures can be used while other actions are implemented to restore proper channel and riparian function (i.e., natural watershed processes). The manual addition of instream structures is usually not a long-term recovery action and should not be used in place of riparian or other restoration activities that promote reestablishment of natural watershed processes. However, if recovery of natural watershed processes cannot be achieved, the use of instream structures is a reasonable option.

- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes where appropriate and identify long-term opportunities for enhancing these conditions.
- Restore natural sediment delivery processes by improving road network, restoring natural floodplain connectivity, riparian health, natural bank erosion, and wood recruitment.
- Replace nutrients in tributaries that formerly were provided by salmon returning from the sea.
- Reduce the abundance and distribution of non-native species that compete and interbreed with or prey on listed species in spawning, rearing, and migration areas.

Long-Term Objectives

- Protect areas with high ecological integrity and natural ecosystem processes.
- Maintain connectivity through the range of the listed species where feasible and practical.
- Maintain suitable stream flows (within natural hydrologic regimes and existing water rights) for spawning, rearing, and migration.
- Protect and restore water quality where feasible and practical within natural constraints.
- Protect and restore off-channel and riparian habitat.
- Increase habitat diversity by rebuilding, maintaining, and adding instream structures (e.g., large woody debris, rocks, etc.) where long-term channel form and function efforts are not feasible.
- Reduce sediment recruitment where feasible and practical within natural constraints.
- Reduce the abundance and distribution of non-native species that compete and interbreed with or prey on listed species in spawning, rearing, and migration areas.

Administrative/Institutional Objectives

- Maximize restoration efficiency by concentrating habitat actions in currently productive areas with significant scope for improvement and areas where listed species will benefit.
- Develop incentive and collaborative programs with local stakeholders and land owners to enhance and restore habitat within productive areas.
- Strive to secure compliance with Federal, State, and local regulatory mechanisms designed to conserve fishery resources, maintain water quality, and protect aquatic habitat.
- Counties will continue to consider recovery needs of salmon and trout in comprehensive land-use planning processes.

- Provide information to the public on the importance of "healthy"[6] streams and the potential effects of land and water management activities on the habitat requirements of listed species.
- Until recovery is achieved, improve or streamline the permitting process for conducting research and monitoring on ESA-listed species and for implementing restoration actions.
- Develop, maintain, and provide a comprehensive inventory of habitat projects and their costs and benefits (effectiveness) to the public annually.

Research and Monitoring Objectives

- Monitor the effectiveness of each "class" of habitat action implemented in the Upper Columbia Basin on listed species and community structure.
- Accurately monitor trends in abundance, productivity (including smolts/redd), spatial structure, and diversity at the population and subpopulation scale.
- Assess stream flows (within the natural hydrologic regime and existing water rights) suitable for spawning, rearing, and migration (based on current research and modeling).
- Implement current monitoring protocols and continue to develop standardized monitoring methods.
- Examine relationships between habitat and biological parameters at coarse (landscape) and fine (stream segment) scales.
- Update, revise, and refine watershed and salmonid performance assessment tools (e.g., Ecosystem Diagnosis and Treatment analysis) to adaptively manage the implementation and prioritization strategy.
- Examine the effects of non-native species on listed species.
- Assess abundance and consumption rates of non-native fish that feed on listed species.
- Conduct channel migration studies within each subbasin to identify priority locations for protection and restoration.
- Examine fluvial geomorphic processes within each subbasin to assess how these processes affect habitat creation and loss.
- Inventory and assess fish passage barriers and screens within each subbasin.
- Conduct hydrologic assessments to better understand water balance and surface/groundwater relations within the subbasins (similar to studies conducted in the Methow by the USGS) and relationships to salmonid utilization and survival.

This plan recognizes that at some point the implementation of habitat actions will provide little benefit to the listed species because the habitat has achieved its greatest productivity potential

[6] "Healthy" is a relative term and is used in this plan to mean the habitat conditions necessary to sustain the listed species indefinitely.

within natural, social, and economic constraints. That is, at some point in the future, habitat improvements through protection and restoration will have a limited effect on fish habitat. This plan promotes an end point of habitat improvements that when met will conclude the responsibility of landowner action to improve or protect habitat, regardless of the status of the listed species.

Integration of Actions

The results of preliminary analyses indicate that the implementation of recommended actions in this Plan will move the listed fish species toward recovery. This will occur if actions are implemented within all sectors (Harvest, Hatchery, Hydro, and Habitat). Recovery cannot be achieved by implementing actions within only one sector (e.g., Habitat). Recovery will also require the implementation of actions outside the Upper Columbia Basin (i.e., in the lower Columbia River, estuary, and ocean).

Recovery actions recommended in this plan should significantly improve the abundance and productivity of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Preliminary analysis suggests that the implementation of recommended recovery actions within all sectors may increase the survival of spring Chinook populations from 99-198%, while steelhead population survivals may increase from 85-226%. There are currently no estimates for bull trout. The amount of survival improvement depends on the specific population and the "intensity" at which recommended actions are implemented.

Implementation of recovery actions within the hatchery and habitat sector should also improve the spatial structure and diversity of the Upper Columbia populations. Implementing actions recommended within the hatchery sector should reduce threats to and improve opportunities for meeting diversity requirements.

Time and Cost Estimates

The ESA section 4(f)(1) requires that the recovery plan include ''estimates of the time required and the cost to carry out those measures needed to achieve the Plan's goal and to achieve intermediate steps toward that goal'' (16 U.S.C. 1533[f][1]). The Upper Columbia Plan contains an extensive list of actions that need to be undertaken to recover spring Chinook and steelhead; however, there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding. The Upper Columbia Plan states that if its recommended actions are implemented, recovery of the spring Chinook salmon ESU and the steelhead DPS is likely to occur within 10 to 30 years. The cost estimates cover work projected to occur within the first 10-year period. Before the end of this first implementation period, specific actions and costs will be estimated for subsequent years, to achieve long-term goals and to proceed until a determination is made that listing is no longer necessary.

The estimated cost of restoring habitat for spring Chinook, steelhead, and bull trout in the Upper Columbia Basin is at least $296 million over the first 10-year period. This estimate includes expenditures by local, Tribal, State, and Federal governments and private business and individuals in implementing both capital projects and non-capital work. Although these costs are attributed to spring Chinook, steelhead, and bull trout conservation, other species will also benefit.

There are no estimated costs associated with hatchery programs because these programs are funded to achieve specific program objectives, which may change based on monitoring and evaluation. The cost estimate does not include expenses associated with implementing actions within the lower Columbia River, in the estuary, within the Federal Columbia River Power System, or the cost of implementing measures in the Public Utility District Habitat Conservation Plans and Settlement Agreements. Cost estimates for these items are included in two modules that NMFS developed because of the regional scope and applicability of the actions. These modules are incorporated into the Upper Columbia Plan by reference and are available on the NMFS Web site: www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm. The hydropower cost estimates will be updated over time, as the section 7 consultation on the remanded 2004 FCRPS BiOp is completed. The estuary recovery costs could be further refined following public comment on the ESA recovery plan for the three listed lower Columbia ESUs and one listed Lower Columbia steelhead DPS in 2007. There are virtually no estimated costs for recovery actions associated with harvest to report at this time. This is because no actions are currently proposed that go beyond those already being implemented through ***U.S. v. Oregon*** and other harvest management forums. In the event that additional harvest actions are implemented through these forums, those costs will be added during the implementation phase of this recovery plan. All cost estimates will be refined and updated over time.

The Plan estimates it may cost a total of $10 million to cover agency and organization staffing costs during the first 10 years of plan implementation ($1 million/year), and it is conceivable that this level of effort will need to continue for the Plan's duration. Also, continued actions in the management of habitat, hatcheries, and harvest, including both capital and non-capital costs, will likely warrant additional expenditures beyond the first 10 years. Although it is not practicable to accurately estimate the total cost of recovery, it appears that most of the costs will occur in the first 10 years. Annual costs are expected to be lower for the remaining years, thus the total for the entire period (years 11-30) may possibly range from $150 million to $200 million.

Funding Strategy

It is uncertain exactly how recovery will be funded in the Upper Columbia Basin. Habitat Conservation Plans and binding mitigation agreements help guarantee that some programs (e.g., state-run mitigation hatchery programs, tributary habitat fund, etc.) have secure funding and will continue operating into the future. However, these programs fall short of funding the total needs of this plan. Additional funding from the following sources will be required to implement this recovery plan.

- The Washington Salmon Recovery Funding Board.
- Public Utility District funds.
- The Bonneville Power Administration (BPA) Fish and Wildlife Program.
- The Federal Columbia River Power System Biological Opinion.
- Appropriations from the Washington State Legislature for state agency budgets (WDFW, WDOE, Conservation Districts).
- Pacific Coast Salmon Recovery Fund (NMFS).

- Appropriations from the U.S. Congress for federal agency (USACE, USFWS, USGS, USFS, NRCS, BOR, and BLM).
- Local government mechanisms funded through state legislative appropriations.
- Other nongovernmental organizations such as the National Fish and Wildlife Foundation, Regional Fishery Enhancement Groups, the Bonneville Environmental Foundation, and the Bullitt Foundation.
- Voluntary projects funded through public and private partnerships.

Because of limited resources, recommended actions will be funded according to a prioritization framework that is based on a balance between biological benefit of the action, and the cost and feasibility of implementing the action. Projects that address primary limiting factors, have high biological benefit, are relatively inexpensive, and are feasible to implement will receive highest funding priority.

Implementation and Coordination

The UCSRB is the coordinating body for the plan and it is their responsibility to make sure the plan is implemented in a voluntary manner. An Implementation Team, composed of a Leader, three Lead Entity representatives (one from each County), the Upper Columbia Regional Technical Team, local, State, Federal, and Tribal resource management agencies and others including local stakeholders, will be responsible for implementing the plan, tracking progress, identifying milestones and benchmarks, and sequencing tasks. The Implementation Team will be involved in all issues related to recovery actions, and will work within the framework of the UCSRB, ***U.S. v Oregon***, Habitat Conservation Plans for the Public Utility Districts, Biological Opinion and Anadromous Fish Agreement, Section 7 consultations, the Mitchell Act, Hatchery and Genetic Management Plans, and federal trust responsibilities to the tribes. The Implementation Team will work closely with local habitat groups, which will be responsible for identifying specific habitat restoration actions and coordinating activities within their respective subbasins. All proposed recovery actions will be coordinated with local stakeholder input and local stakeholders will be included in the development of any of the planning processes that may affect their interests.

Monitoring and Adaptive Management

The beneficial actions identified in this plan are believed to represent a sound approach based on available information and tools, and they address the range of known threats. However, uncertainty exists for many actions because of insufficient information. This plan does not assume risk-free actions with perfectly predictable results. Therefore, this plan will monitor[7] or assess the outcomes of different recovery actions. The plan is “adaptive” in the sense that it will take this information, combined with cost and benefit estimates, and re-evaluate priorities and reasonable actions. The intent is to use the information as a means of selecting what actions will be sufficient for recovery. This plan is a “living document” that will be updated as new information becomes available. All significant modifications, especially those that change the

[7] Monitoring will include implementation, status/trend, and effectiveness monitoring.

regulatory environment or impose additional costs or restrictions on private property and water rights, will be submitted for public review and comment by local governments and stakeholders, and approved by the UCSRB before implementation.

Assurances

Assurances are needed that good-faith recovery efforts, which are consistent with this recovery plan and are based on the best scientific information available, will reduce the risk that the public would be prosecuted for a take of listed species. In other words, if an entity has corrected problems (threats and limiting factors) that have been identified as detrimental to listed species, there must be a point at which they are no longer responsible for salmonid population problems. Currently, assurances are legally guaranteed only under Section 4, Section 7, and Section 10 of the ESA. The UCSRB encourages the federal agencies to explore additional opportunities for assurances. A legally binding definition of discharge of responsibility for impacts to spring Chinook, steelhead, and bull trout populations would increase voluntary participation in recovery planning and implementation.

Estimated Date of Recovery

The time necessary to achieve reclassification for spring Chinook and steelhead and recovery of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin depends on the status of the fish species, factors affecting their viability, implementation and effectiveness of recovery actions, and responses to recovery actions. A large amount of work within all sectors is needed to recover the species. If the actions recommended in this plan are implemented, recovery of the three listed species should occur within 10 to 30 years.

1 Introduction

The National Oceanographic Atmospheric Administration Fisheries (NOAA Fisheries) issued a rule listing Upper Columbia River Steelhead (***Oncorhynchus mykiss***) as endangered under the Endangered Species Act (ESA) on August 18, 1997 (62 FR 43937). On January 5, 2006, NOAA Fisheries reclassified the Upper Columbia River Steelhead Distinct Population Segment (DPS) as threatened (50 FR 834), based in part on the agency's application of the ESA Hatchery Listing Policy (70 FR 123). On June 13, 2007, the U.S. District Court set aside that ESA Hatchery Listing Policy as contrary to the ESA. Consequently, the 2006 listing was invalidated and the endangered status of the Upper Columbia Steelhead DPS reinstated (Trout Unlimited et al. v. Lohn). The Upper Columbia River Steelhead DPS occupies the Columbia River and its tributaries between the Yakima River and Chief Joseph Dam. On March 24, 1999, NOAA Fisheries listed the Upper Columbia River Spring-run Chinook Salmon (***O. tshawytscha***) as endangered (64 FR 14307). The Upper Columbia River Spring-run Chinook ESU occupies the Columbia River and its tributaries between Rock Island Dam and Chief Joseph Dam.

The U.S. Fish and Wildlife Service (USFWS) issued a final rule listing the Columbia River and Klamath River populations of bull trout (***Salvelinus confluentus***) as threatened under the ESA on June 10, 1998 (63 FR 31647). The USFWS considers the Columbia River population as one of five distinct population segments (DPS) (i.e., they meet the joint policy of the USFWS and NOAA Fisheries regarding the recognition of distinct vertebrate populations). The USFWS issued another final rule coterminously listing the bull trout in all DPSs as threatened on November 1, 1999 (64 FR 58910). This recovery plan addresses the recovery of bull trout in the Upper Columbia Basin, encompassing the basin upstream of the confluence of the Yakima River to Chief Joseph Dam, including the mainstem Columbia River and all of its associated tributaries. This geographic area is referred to as the Upper Columbia Recovery Unit in the Bull Trout Draft Recovery Plan (USFWS 2002). Bull trout in the Upper Columbia constitute one portion of the total Columbia River population.

The Upper Columbia Salmon Recovery Board (UCSRB)[8] developed this plan for the recovery of endangered spring Chinook and endangered steelhead and threatened bull trout in the Upper Columbia River Basin (commonly called the Upper Columbia Region or Upper Columbia Basin). This plan is an outgrowth and culmination of several conservation efforts in the Upper Columbia Basin including efforts related to the ESA, state-sponsored recovery efforts, subbasin planning, watershed planning, and tribal recovery.

[8] The UCSRB consists of Chelan, Douglas, and Okanogan counties, the Confederated Tribes of the Colville Indian Reservation, and the Yakama Nation.

Watershed planning began when the 1998 Washington State Legislature passed House Bill (HB) 2514, codified into RCW 90.82, to set a framework for addressing the state's water resources issues. In 2001, HB 1336 amended the law. Currently RCW 90.82 states:

> The legislature finds that the local development of watershed plans for managing water resources and for protecting existing water rights is vital to both state and local interests. The local development of these plans serves vital local interests by placing it in the hands of people: Who have the greatest knowledge of both the resources and the aspirations of those who live and work in the watershed; and who have the greatest stake in the proper, long-term management resources. The development of such plans serves the state's vital interests by ensuring that the state's water resources are used wisely, by protecting existing water rights, by protecting instream flows for fish and by providing for the economic well-being of the state's citizenry and communities. Therefore the legislature believes it necessary for units of local government throughout the state to engage in orderly development of these watershed plans.

The purpose of the 1998 Watershed Management Act (WMA) is to provide a framework for local government, interest groups, and citizens to identify and solve water-related issues collaboratively in each of the 62 Water Resource Inventory Areas (WRIAs) of Washington State. Water quantity is a required element of the plan, with water quality, stream flows, habitat, and storage as optional elements to be included. Watershed plans have been completed in the Wenatchee, Entiat, Methow, Foster Creek, and Moses Coulee WRIAs and adopted respectively by Chelan, Okanogan, and Douglas counties. Portions of these plans are integral parts of the recovery plan.

Recently, the Northwest Power and Conservation Council (NPCC; formerly the Northwest Power Planning Council) adopted a revised Fish and Wildlife Program for the Columbia River Basin with the intent that the program will be more comprehensive than, but complimentary to, regional, state, county, and tribal efforts. Their revised program calls for an ecosystem-based approach for planning and implementing fish and wildlife recovery. This effort resulted in subbasin plans. Pertinent information from both subbasin plans and watershed plans formed the basis for much of this recovery plan. Other species, including resident, migrant, and anadromous species are expected to benefit from this plan.

1.1 Definition of a Recovery Plan

As outlined in Section 4(f)(1) of the ESA, a recovery plan is defined as follows:

The Secretary shall develop and implement plans (hereafter in this subsection referred to as "recovery plans") for the conservation and survival of endangered species and threatened species listed pursuant to this section, unless he finds that such a plan will not promote the conservation of the species. The Secretary, in development and implementing recovery plans, shall, to the maximum extent practicable-

> ***(A) give priority to those endangered species or threatened species, without regard to taxonomic classification, that are most likely to benefit from such plans, particularly***

those species that are, or may be, in conflict with construction or other forms of economic activity;

(B) incorporate in each plan-

(i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;

(ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and

(iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

This document is designed to be a roadmap showing a possible path to the recovery of salmonids in the Upper Columbia. While it contains much of the available science, it is not intended to be the definitive method or means of recovery. This plan is to be used to guide federal agencies charged with species recovery in their actions. In and of itself, this plan is a non-regulatory document. As such, it is not intended to be nor may it serve as a regulatory document forcing landowner action. Any such regulatory actions deemed necessary as a result of this document must be accompanied by a clear legislative mandate to that end.

The plan may be used to inform state and local agency planning and land use actions, but it may not be deemed to place requirements on such entities. The goal of this plan is to offer options for future action to enhance the survival of species. No mandate on state or local agencies may be construed from this plan, and the plan may not be cited as creating a need for new regulatory actions at the state or local level unless clear legislative authority is first adopted.

This plan is limited to address listed salmonid species. If any threatened or endangered species were introduced into an area where it has been designated as extirpated, this population would be treated as an experimental population (ESA Section 10(j) or other mechanisms under ESA), which would not increase ESA liabilities for landowners.

1.2 Organization of Plan

This plan, the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, describes a process and recommends actions to remove or minimize the threats to spring Chinook and steelhead long-term survival and reverse their decline within the Upper Columbia Basin. This plan is also expected to benefit other sensitive or at-risk species.

1.2.1 Executive Summary

The Executive Summary provides a succinct description of the recovery plan. It identifies the problem, clearly states the goal and scope of the plan, summarizes the strategies, and outlines the recommended actions and commitments needed for recovery of the listed species.

1.2.2 Section 1 (Introduction)

The Introduction provides general background information, including a brief description of the Upper Columbia Basin, current conditions of the listed species and their habitats, desired outcomes from implementing the plan, the approach to developing recovery strategies and actions, the relationship of this plan to other recovery activities, public participation in the development of this plan, and who was involved in developing this plan.

1.2.3 Section 2 (Species Status)

This section briefly describes the current and historical status of Upper Columbia spring Chinook, steelhead, and bull trout. It focuses on four Viable Salmonid Population (VSP) parameters: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). Historical distribution, habitat use, and production potential within the Upper Columbia Basin have been estimated using Ecosystem Diagnostic and Treatment (EDT) analysis (see Okanogan, Methow, and Entiat subbasin plans); quantitative habitat analysis (QHA) (see Wenatchee and Upper Middle Mainstem subbasin plans); and using an analysis commonly referred to as the Intrinsic Potential Analysis (NWFSC 2004) (see NOAA Fisheries Northwest Fisheries Science Center (NWFSC)). This section also reviews community structure within the Upper Columbia Basin. Section 2 provides only a very brief discussion on species status. A more detailed discussion can be found in watershed plans and subbasin plans.

1.2.4 Section 3 (Factors for Decline)

This section briefly describes the major factors that led to the decline of Upper Columbia spring Chinook, steelhead, and bull trout. This section also identifies the major threats to recovery of the three species. The reader should consult watershed plans and subbasin plans for a detailed description of factors causing decline of these and other species.

1.2.5 Section 4 (Recovery Criteria)

This section identifies the objectives and targets that must be met for recovery of the ESU, DPS, and bull trout. This section identifies the goals, objectives, and criteria for recovery, outlines desired future conditions and recovery targets for abundance, productivity, spatial structure, and diversity, and also identifies a timeframe for opportunities and goals. The Interior Columbia Basin Technical Recovery Team (ICBTRT)[9] has developed recommendations for biological criteria for population and ESU-level viability (criteria that indicate when populations or ESUs and DPSs have a high probability of persistence into the future). Recommendations submitted by the ICBTRT to NOAA Fisheries are included in this plan (McElhany et al. 2000; ICBTRT 2004a).

[9] The ICBTRT consists of representatives from NOAA Fisheries, Columbia River Inter-Tribal Fish Commission, U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, the University of Montana, and the University of Washington.

1.2.6 Section 5 (Recovery Program)

This section of the plan identifies the recommended actions that are needed to achieve recovery of Upper Columbia ESA-listed spring Chinook, steelhead and bull trout. Actions are recommended and prioritized for each “H” sector (Harvest, Hatchery, Hydropower, and Habitat) and for each listed population, but are not prioritized across H’s. This section also describes the interaction of actions and what changes in VSP parameters can be expected for each population (and ESU) if actions are implemented. Within this section local government programs and policies are examined and compared with possible effects to the VSP parameters. Finally, this section identifies performance measures, responsible parties, compliance, coordination, and commitments.

1.2.7 Section 6 (Social/Economic Considerations)

The plan will include coarse-scale cost estimates for the suite of actions and cost effectiveness[10] of some actions.

1.2.8 Section 7 (Relationship to Other Efforts)

This section describes how the plan relates to other efforts that intend to help restore fish populations and/or habitat in the Upper Columbia River Basin. For example, this section identifies how this plan meshes with NOAA Fisheries Biological Opinions, the U.S. Fish and Wildlife Service (USFWS) Bull Trout Draft Recovery Plan and Biological Opinions, the mid-Columbia Habitat Conservation Plans (HCPs), watershed plans and subbasin plans, and other conservation efforts. Each of these includes its own conservation efforts in varying stages of development and implementation. This plan builds upon the foundation established by these conservation plans and adopts portions of those plans where appropriate.

1.2.9 Section 8 (Plan Implementation)

Parties to this plan recognize that the plan can succeed only if local, state, and federal interests take ownership of it and are involved in implementation and adaptive management. This section describes how, when, and by whom the recommended actions will be implemented and monitored. Because there is some uncertainty associated with some actions, this section will identify those uncertainties and describe how they will be addressed. The plan stresses the importance of adaptive management[11] and provides a mechanism for monitoring the progress of the plan and refining the plan over time. In addition, this section will describe how the plan will

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[10] Cost effectiveness refers to the relationship between costs and potential benefits (biological and social).

[11] Adaptive management applies the concept of experimentation to design and implementation of natural resource plans and policies (Lee 1993). As stated in Lee (1993), “***Adaptive management encourages deliberate design of measures. This assures that both success and failures are detected early and interpreted properly as guidance for future action. Information from these evaluations should enable planners to estimate the effectiveness of protection and enhancement measures on a systemwide basis. Measures should be formulated as hypotheses. Measures should make an observable difference. Monitoring must be designed at the outset. Biological confirmation*** [plus social acceptance] ***is the fundamental measure of effectiveness.***” (See Section 8.)

involve the public during implementation and how it will seek broad support. Finally, this plan will link specific actions to responsible parties and funding sources.

1.3 Regional Setting

This recovery plan is intended for implementation within the Upper Columbia River Basin, which includes the Columbia River and its tributaries upstream of the confluence of the Yakima River to the base of Chief Joseph Dam (**Figure 1.1**). Implementation of recovery actions outside the Upper Columbia Basin (i.e., out-of-subbasin hydro, harvest, and estuary actions) are incorporated in this plan by reference and managed in other forums such as ***U.S. v. Oregon***, the Lower Columbia River Estuary Partnership, and the FCRPS. This area forms part of the larger Columbia Basin Ecoregion (Omernik 1987). The Wenatchee, Entiat, and Chelan subbasins are in the Northern Cascades Physiographic Province, and the Okanogan and Methow subbasins are in the Okanogan Highlands Physiographic Province. The geology of these provinces is somewhat similar and very complex, developed from marine invasions, volcanic deposits, and glaciation. The river valleys in this region are deeply dissected and maintain low gradients except in headwaters. The climate includes extremes in temperatures and precipitation, with most precipitation falling in the mountains as snow. Melting snowpack, groundwater, and runoff maintain stream flows in the area. Because a large portion of the Upper Columbia Basins is publicly owned, management of public lands to improve forest and ecosystem health could have direct and indirect benefits to the listed species.

The Upper Columbia Basin consists of six major "subbasins" (Crab, Wenatchee, Entiat, Lake Chelan, Methow, and Okanogan subbasins), several smaller watersheds, and the mainstem Columbia River (**Figure 1.1**). This area captures the distribution of Upper Columbia River spring Chinook, steelhead, and bull trout. The ICBTRT[12] identified independent populations of spring Chinook and steelhead within the Upper Columbia River Basin (ICBTRT 2003).

The ICBTRT recognized three extant, independent populations of spring Chinook within the Upper Columbia ESU (Wenatchee, Entiat, and Methow), with one extirpated stock of spring Chinook identified in the Okanogan subbasin. While Chinook also rear in some of the smaller tributaries to the Columbia River, the particular life-history type (spring or summer)[13] is unknown.

The ICBTRT recognizes five steelhead populations within the Upper Columbia DPS (Wenatchee, Entiat, Methow, Okanogan and Crab Creek populations). Steelhead also exist within smaller tributaries to the Columbia River, such as Squilchuck, Stemilt, Colockum, Tarpiscan, Tekison, Quilomene/Brushy, and Foster creeks, and the Chelan River tailrace. Steelhead in these smaller tributaries are not separate populations, but are included in the closest

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[12] The ICBTRT was convened by NOAA Fisheries to provide technical guidance and recommendations relating to the recovery of salmon and steelhead in the interior Columbia Basin.

[13] Spring Chinook are also referred to as "early run," "stream-type," or "stream-annulus" Chinook, while summer Chinook are also referred to as "late-run," "ocean-type," or "ocean-annulus" Chinook. Very simply, spring Chinook enter the Columbia River earlier than summer Chinook, they spawn earlier and higher in watersheds than do summer Chinook, and they tend to rear within tributary streams or lakes (Lichatowich 1999) for one year before migrating to tthe sea as smolts in the spring. In this document we identify Chinook as either "spring" or "summer" fish.

upstream population. For example, Squilchuck, Stemilt, Colockum, Tarpiscan, Tekison, and Quilomene/Brushy are all part of the Wenatchee steelhead population. A detailed description of small tributaries to the Columbia River can be found in the Upper Middle Mainstem subbasin plan (2004).

The USFWS (2002) has identified three "core" areas supporting bull trout populations (Wenatchee, Entiat, and Methow subbasins) and two areas designated as "unknown occupancy" (Lake Chelan and Okanogan subbasins)[14]. The USFWS has also identified "local" populations within each of the three core areas.

1.3.1 Wenatchee Subbasin

The Wenatchee subbasin is located in north-central Washington and lies entirely within Chelan County. The subbasin consists of about 854,000 acres. About 90% of the subbasin is in public ownership. The remaining 10% is privately owned and is primarily within the valley bottoms. The subbasin consists of nine primary watersheds: Mission, Peshastin, Chumstick, Icicle, Chiwaukum, and Nason creeks, the Chiwawa, White, and Little Wenatchee rivers (**Figure 1.2**), and two mainstem Wenatchee River "watersheds:" the lower and upper Wenatchee River (the upper river includes Lake Wenatchee). Spring Chinook, steelhead, and bull trout spawn and rear in the subbasin. A more detailed description of the Wenatchee Subbasin can be found in the Wenatchee Subbasin Plan (2005).

1.3.2 Entiat Subbasin

The Entiat subbasin is located in north-central Washington and lies entirely within Chelan County. The subbasin consists of about 298,000 acres. About 91% of the subbasin is in public ownership. The remaining 9% is privately owned and is primarily within the valley bottoms. The subbasin consists of two primary watersheds: Entiat and Mad rivers (**Figure 1.3**). Spring Chinook, steelhead, and bull trout spawn and rear in the Entiat subbasin. A more detailed description of the Entiat Subbasin can be found in the Entiat WRIA 46 Management Plan (CCCD 2004) and the Entiat Subbasin Plan (2004).

1.3.3 Lake Chelan Subbasin

The Lake Chelan subbasin is located in north-central Washington and lies entirely within Chelan County (**Figure 1.1**). The subbasin consists of 599,905 acres. About 87% of the subbasin is in public ownership. The remaining 13% is privately owned. The most prominent feature of the subbasin is Lake Chelan, which occupies about 50 miles of the 75-mile-long basin. The majority of inflow to Lake Chelan is from two major tributaries, the Stehekin River (65%) and Railroad Creek (10%). About 50 small streams provide the remaining 25% of the inflow. Because of the shape of the valley, most tributaries are relatively steep and short. Lake Chelan drains into the 4.1-mile-long Chelan River. Presently, nearly all the flow from Lake Chelan is diverted through a penstock, which passes the water through the Lake Chelan powerhouse located near the mouth of the river. Steelhead spawn and rear in the Chelan tailrace. No anadromous fish enter Lake Chelan because natural barriers prevent their upstream migration in the Chelan River. Although

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[14] "Occupancy unknown" is defined as areas where bull trout existed historically but their population status is currently unknown (USFWS 2002).

bull trout historically occurred in the subbasin, they have not been observed in the subbasin for several decades. Adult bull trout have occasionally been observed in the Chelan tailrace. A more detailed description of the Lake Chelan subbasin can be found in the Lake Chelan Subbasin Plan (2004).

1.3.4 Methow Subbasin

The Methow subbasin is located in north-central Washington and lies entirely within Okanogan County. The subbasin consists of about 1,167,764 acres. About 89% of the subbasin is in public ownership. The remaining 11% is privately owned and is primarily within the valley bottoms. The subbasin consists of ten primary watersheds: Early Winters Creek, Upper Methow, Lost, Middle Methow, Chewuch, Twisp, Beaver Creek, Gold Creek, Libby Creek, and the Lower Methow rivers (**Figure 1.4**). Spring Chinook, steelhead, and bull trout spawn and rear in the Methow subbasin. A more detailed description of the Methow subbasin can be found in the Methow Watershed Plan (2004) and Methow Subbasin Plan (2005).

1.3.5 Okanogan Subbasin

The Okanogan subbasin is the third largest of the Columbia River subbasins. Originating in British Columbia, the Okanogan subbasin enters the Columbia River between Wells Dam and Chief Joseph Dam. The subbasin consists of about 5,723,010 acres. About 74% of the subbasin is in British Columbia and 26% is in Washington State. The portion within Washington State lies entirely within Okanogan County. About 41% is in public ownership, 21% is in Tribal ownership, and the remaining 38% is privately owned and is primarily within the valley bottoms. There are three major watersheds within the subbasin in the State of Washington (Similkameen, Omak, and Salmon; **Figure 1.5**). The Similkameen River, located primarily in Canada, contributes 75% of the flow to the Okanogan River. Steelhead spawn and rear in the Okanogan subbasin. The tribes are in the process of introducing an experimental population of spring Chinook into the subbasin. Presence of bull trout in the Okanogan subbasin is unknown. A more detailed description of the Okanogan subbasin in the U.S. can be found in the Okanogan Watershed Plan (in development) and Okanogan Subbasin Plan (2005) and in Canada in Rae (2005).

1.3.6 Crab Creek Subbasin

The Crab Creek subbasin is located in central Washington within portions of Douglas, Lincoln, Adams, Grant, and Spokane counties (**Figure 1.1**). Considered one of the longest ephemeral streams in North America, Crab Creek flows southwest for about 140 miles, draining into the Columbia River near the town of Schwana, five miles downstream from Wanapum Dam. The subbasin consists of about 3,261,720 acres, most of which are used to raise crops. Anadromous salmonids, including steelhead and summer Chinook use only the lower portion of Crab Creek. These fish are known to occur as far upstream as Red Rock Coulee. Unlike historical conditions, the lower portion of Crab Creek currently has permanent stream flows, because of the Columbia Basin Project.

Although the ICBTRT identified steelhead in Crab Creek as an independent population within the Upper Columbia DPS, this plan will only generally address recovery of steelhead in Crab Creek. This decision is based on the following information.

- The decision by the ICBTRT to designate steelhead in Crab Creek as an independent population occurred too late for the Upper Columbia Salmon Recovery Board (UCSRB) to seek participation by the appropriate entities and stakeholders.
- There remains uncertainty about the genetics of steelhead and resident rainbow in Crab Creek.
- The contribution of steelhead to the historic steelhead-rainbow population is uncertain, but it is thought to be less than other steelhead-rainbow populations in the Interior Columbia Basin.
- There is uncertainty regarding water regimes and historic connectivity between the resident portion of the population in the upper watershed and the anadromous portion in the lower watershed.
- It is possible that the steelhead population was not viable historically because of environmental conditions (e.g., intermittent stream flows and high water temperatures).
- It is possible that steelhead in Crab Creek are dependent on resident forms and strays from other populations.

This plan recognizes that the Upper Columbia Steelhead DPS would be at a lower risk of extinction with a viable Crab Creek population. However, given the uncertainty of consistent stream flows and the assumption that the resident component of the population was the primary driver in the viability of the historic population, this plan concludes that the other populations of steelhead in the Upper Columbia were not and are not dependent upon the Crab Creek population to be a viable DPS. Therefore, recovery of the DPS can be achieved without the recovery of steelhead in Crab Creek.

1.4 Current Conditions

Current conditions in the Upper Columbia Basin are described in detail in watershed plans and subbasin plans. A summary of historic and current conditions of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin can be found in Section 2. What follows is a very brief summary of findings by NOAA Fisheries and the USFWS during their status reviews at the time of listing and more recent information contained in the watershed and subbasin plans.

1.4.1 Spring Chinook

At the time of listing (1999), spring Chinook in the Upper Columbia Basin ESU exhibited very low abundance (64 FR 14307). At that time, redd counts were declining severely and individual populations within the ESU were small, with none averaging more than 150 adults annually. Trends were mostly downward and a few local populations exhibited rates of decline exceeding 20% per year. Since 2000, adult spring Chinook numbers have increased in the Upper Columbia Basin (see Section 2).

1.4.2 Steelhead

At the time of the initial listing (1997 when the steelhead—then ESU, now DPS—was listed as ***endangered***), naturally produced steelhead in the Upper Columbia exhibited low abundance, both in absolute numbers and in relation to numbers of hatchery fish throughout the region (62 FR 43937). At that time, trends in natural steelhead abundance had declined or remained relatively constant in the ESU and natural adult replacement ratios were low (e.g., 0.25 and 0.30 for Entiat and Wenatchee steelhead, respectively), indicating that the populations were not self-sustaining. Since 2000, adult steelhead numbers have increased in the Upper Columbia Basin (see Section 2). In January 2006, the DPS was reclassified as ***threatened,*** primarily because the hatchery programs in the Upper Columbia Basin collectively mitigate the immediacy of extinction risk. However, in June 2007, a federal judge set aside NMFS' Hatchery Listing Policy, ruling that it was not valid to count the hatchery component of this steelhead DPS in determining their status under the Endangered Species Act. The decision reinstated the ***endangered*** status of the Upper Columbia Steelhead DPS. The naturally produced component of steelhead is at a high risk over the long term (100 years) because of low productivity.

1.4.3 Bull Trout

At the time of listing (1998), bull trout abundance in the Upper Columbia Basin was relatively low, with the exception of the Lake Wenatchee subpopulation, which was considered "strong" and increasing or stable (63 FR 31647). Most of the subpopulations exhibited "depressed" or unknown trends and consisted of a single life-history form. Bull trout are designated as "occupancy unknown" in the Okanogan and Lake Chelan subbasins. The USFWS Draft Recovery Plan indicates that bull trout in the Wenatchee, Entiat, and Methow core areas persist at low abundance. Bull trout populations from each of the core areas in the Upper Columbia basin are known to use the mainstem Columbia River (USFWS 2002). Currently the USFWS is developing a five-year review of the status of bull trout since listing.

1.4.4 Harvest

Restrictive fisheries currently prevent large numbers of Upper Columbia Basin spring Chinook, steelhead, and bull trout from being harvested. A federally established limit of 5% incidental take of naturally produced spring Chinook and steelhead in the Lower Columbia River was set in 2004 for non-tribal fisheries. Tribal fisheries in Zone 6 (a 130-mile treaty Indian commercial fishery between Bonneville Dam and McNary Dam) harvest an additional incidental take of 5-7%. The ESA listing precludes a directed fishery on naturally produced spring Chinook or steelhead in the Upper Columbia Basin. There is, however, a directed fishery on hatchery-origin steelhead, with the intent to remove excess hatchery steelhead. There is also a fishery on bull trout in the Lost River within the Methow Subbasin. This was established under a 4d Rule for sport fishing regulations (63 FR 31647). The UCSRB has a firm commitment to pursue and support all possible fishing opportunities (sport and tribal) in the Upper Columbia consistent with meeting ESA obligations for listed populations.

1.4.5 Hatcheries

There are 12 hatcheries or artificial production programs in the Upper Columbia Basin operated by the USFWS, Washington Department of Fish and Wildlife (WDFW) and the Confederated Tribes of the Colville Indian Reservation (Colville Tribes) that produce spring Chinook and steelhead (see Section 5.3). These programs annually release about four million spring Chinook in the Entiat, Methow, Okanogan, and Wenatchee subbasins and nearly one million steelhead in the Methow, Okanogan, and Wenatchee subbasins. At the time of listing, NOAA Fisheries included spring Chinook produced at state hatcheries in the ESU, excluding the Ringold Hatchery, because they were derived from endemic stock. They did not include spring Chinook produced at federal hatcheries (Winthrop, Entiat, and Leavenworth hatcheries)[15] in the ESU, because these fish are a mixture of Upper Columbia and Snake River populations. Starting in 2000, Winthrop National Fish Hatchery changed their production stock to be the listed component, while changes in operations at the other two federal facilities are being discussed. Currently, these two other hatcheries raise out-of-basin Carson spring Chinook stocks[16]. Spring Chinook produced at the Winthrop National Fish Hatchery are comprised of Methow Composite stock, which is included in the Upper Columbia ESU. Steelhead produced at the Wells and Eastbank hatcheries and the Winthrop National Fish Hatchery[17] are included in the Upper Columbia Basin steelhead DPS. NOAA Fisheries has concluded that locally derived fish produced in hatcheries are essential for recovery of both the ESU and DPS. Although there is no artificial propagation of bull trout in the Upper Columbia Basin, artificial propagation may be necessary for recovery of the Upper Columbia population (i.e., for Lake Chelan and Okanogan subbasins).

1.4.6 Hydropower

The existence and operation of the Columbia River Hydrosystem[18] presents passage obstacles to both adult and juvenile migrants. Populations of spring Chinook and steelhead in the Okanogan and Methow subbasins must pass through nine dams, populations in the Entiat subbasin must pass through eight dams, and those in the Wenatchee subbasin pass through seven dams. Upper Columbia migrant bull trout also move through the mainstem dams (Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams). Recently, Chelan and Douglas Public Utility Districts HCPs and Settlement Agreements (Grant Public Utility District) were signed by NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), USFWS, Colville Tribes, and the Yakama Nation. The primary goal of the HCPs and Settlement Agreement is to achieve “No Net Impact” (NNI)[19] of the Wells, Rocky Reach, and Rock Island hydroprojects on all anadromous salmonids. The major focus in implementation to achieve the goal of “no-net impact” is through mainstem Columbia River passage survival (adult and juvenile). “Unavoidable mortality” at the dams will be mitigated through artificial production and tributary enhancement. Cooney et al. (2001) estimated that survival would increase 16-25% for steelhead and 21-35% for spring Chinook with the implementation of the mid-Columbia HCPs (see Section 5.4). Federal projects also contribute to the loss of Upper Columbia spring Chinook,

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[15] Federal hatcheries were developed as part of the mitigation for Grand Coulee Dam (Bryant and Parkhurst 1950).

[16] Although the Entiat and Leavenworth hatcheries may move away from out-of-basin stocks, fish produced in these hatcheries are not listed and therefore do not currently contribute to the recovery of listed stocks.

[17] Although steelhead produced at the Winthrop National Fish Hatchery are listed, they are 100% fin-clipped and harvestable.

[18] The Columbia River Hydropower System downstream from Chief Joseph Dam consists of non-federal facilities owned and operated by Public Utility Districts (Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids dams) and federal facilities operated by the Army Corps of Engineers and Bureau of Reclamation (McNary, The Dalles, John Day, and Bonneville dams).

[19] If met, this would equate to a net productivity equivalent to the productivity that could be attained if these projects did not exist.

steelhead, and bull trout. The 2004 Federal Columbia River Power System Biological Opinion, currently in remand, identifies actions to mitigate for the effects of federal hydropower facilities.

1.4.7 Habitat

Human activities acting in concert with natural occurrences (e.g., floods, drought, fires, wind, volcanism, ocean cycles, etc.) within the Upper Columbia Basin have impacted habitat conditions (habitat diversity and quantity, connectivity, and riparian function) and compromised ecological processes. Habitat within many of the upper reaches of most subbasins is in relatively pristine condition. Water quality and quantity have also been affected by land-use and management activities. Loss of large woody debris and floodplain connectivity have reduced overwinter habitat for salmon, steelhead, and bull trout in the larger rivers (i.e., Wenatchee, Entiat, Methow, and Okanogan rivers). Fish management, including introductions and persistence of non-native species continues to affect habitat in some locations (e.g., presence of brook trout in bull trout habitat).

The implementation of several programs and projects that regulate land-use activities on public and private lands have improved habitat conditions (but have not been quantified) over the last decade in the Upper Columbia Basin. Improved farm and ranch practices and numerous voluntary restoration and protection projects have occurred throughout the region. While difficult to quantify, the cumulative effects are important to salmon and trout recovery. Counties continue to protect and enhance critical areas, including salmon and trout habitat through the Growth Management Act and the Shoreline Management Act and their associated administrative codes and local land-use regulations. The Forest Service, the largest landowner in the Upper Columbia Basin, manages spawning and rearing streams through several programs including the Northwest Forest Plan and the PACFISH/INFISH[20] Strategy. WDFW and the Department of Natural Resources also own land in the Upper Columbia Basin and have modified and continue to modify land management practices to improve habitat conditions. The fact remains that habitat improvements are still needed to improve populations of listed species.

1.5 Desired Outcome

Defining recovery goals and criteria begins with a vision statement for the Upper Columbia recovery region. The vision statement provides the context within which recovery goals and criteria are set and strategies and actions are identified. The vision for the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan developed by the Upper Columbia Salmon Recovery Board (UCSRB) is:

> ***Develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well being of the communities both within and outside the recovery region.***

[20] PACFISH is the Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, and Portions of California. INFISH is the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada.

This vision statement includes: (1) meeting recovery goals established for listed populations of spring Chinook, steelhead, and bull trout, (2) achieving sustainable harvests of key species within the recovery region and the Columbia River following recovery, (3) realizing these objectives while recognizing that agriculture and urban development are beneficial to the health of the human environment within the recovery region, (4) continue harvest (tribal and non-tribal) according to existing harvest management processes during the recovery period, and (5) implementing a road map of non-regulatory, voluntary measures that is not intended to override anyone's authority over habitat, hydropower, hatcheries, and harvest.

Recovery of listed populations is based on achieving recovery goals. Because listed anadromous fish species and bull trout have different life-history characteristics (see Section 2), this plan identified different recovery goals for the different species.

The specific goal for spring Chinook and steelhead is:

- **To secure long-term persistence of viable populations of naturally produced spring Chinook and steelhead distributed across their native range.**

Recovery of the spring Chinook ESU will require the recovery of the Wenatchee, Entiat, and Methow populations (ICBTRT 2005). Recovery of the Upper Columbia steelhead DPS will require the recovery of the Wenatchee, Entiat, Methow, and Okanogan populations, but not the Crab Creek population (ICBTRT 2005).

The specific goal for bull trout is:

- **To secure long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed across the native range of the species.**

In summary, recovery requires reducing threats to the long-term persistence of fish populations, maintaining widely distributed and connected fish populations across diverse habitats of their native ranges, and preserving genetic diversity and life-history characteristics (components of VSP). To be consistent with the vision and goals of this plan, listed populations, ESU, and DPS must meet specific criteria associated with each VSP parameter and the goals and objectives identified in the USFWS Draft Bull Trout Recovery Plan. Specific criteria associated with each parameter are identified in Section 4.

This plan recognizes the importance of providing valid metrics for Upper Columbia tributary productivity. It is the policy of the UCSRB to emphasize juvenile salmonid productivity within each tributary as the primary indicator of habitat restoration success for each basin in the Upper Columbia. In addition to evaluating productivity for the entire life cycle (spawner to spawner ratios), this plan looks to identify a measure that focuses on effects of tributary habitat on juvenile salmonid survival, without the confounding effects of mortality outside the subbasin (commonly referred to as out-of-subbasin effects[21]). This will be accomplished primarily by evaluating "smolts per spawner" and/or "smolts per redd." Although this plan does not identify specific recovery criteria based on these factors, this will allow a consistent approach to evaluate

[21] Out-of-subbasin effects (OOSE) include mortality associated with federally owned hydropower projects in the lower Columbia River, mortality in the estuary and ocean, and mortality associated with fisheries (directed and incidental harvest) (Toole et al. 2005).

the level of success for restoration and recovery actions in the Upper Columbia and the quality of habitat in tributaries.

1.5.1 Abundance

This plan will identify actions that if implemented should result in population abundances (or effective population sizes) large enough to have a high probability of surviving environmental variation observed in the past and expected in the future, to be resilient to environmental and anthropogenic disturbances, to maintain genetic diversity, and to support or provide ecosystem functions. In this plan, abundance is expressed as the 12-year geometric mean[22] abundance of naturally produced adult fish on spawning grounds. The 12-year period falls within the recommended guidance of the ICBTRT (8-20 years) and represents two to three generations for spring Chinook and steelhead. The geometric mean provides a better indicator of central tendency than the arithmetic mean, which is often skewed by uncommon large and small returns. For spring Chinook and bull trout, abundance will be based on redd counts. Because of a lack of long-term redd counts, abundance for steelhead will be based on inter-dam counts and radio-telemetry studies.

1.5.2 Productivity

This plan envisions that naturally produced, Upper Columbia spring Chinook and steelhead will support net replacement rates of 1:1 or higher, expressed as the 12-year geometric mean recruits per spawner.[23] This means that on average one or more offspring returns for every fish that spawns. Populations with growth rates greater than one are resilient to negative environmental conditions and can quickly rebound from low abundances. Thus, productivity rates at relatively low numbers of spawners (<500-2000 adults) will need to be considerably higher than one to allow the populations to rapidly return to abundance target levels. It is assumed that all historic populations had high productivity when populations were well below carrying capacity. This plan combines abundance and productivity together using the viability curve concept provided by the ICBTRT (see Section 4).

As noted above, this plan recognizes the importance of juvenile productivity within tributaries as an indicator of habitat restoration success. This will be accomplished by evaluating "smolts per spawner" or "smolts per redd." Although this plan does not identify recovery criteria based on smolts per redd, it does allow for a consistent approach to evaluating restoration actions in tributaries.

Because of a lack of information on the population dynamics of bull trout in the Upper Columbia Basin, productivity will be estimated from temporal trends in redd counts. Recovery is expressed as a stable or increasing trend over a twelve-year period.

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[22] Because population growth is a multiplicative process, the geometric mean gives a better estimate of average population growth than does the arithmetic mean (Gotelli and Ellison 2004). The geometric mean is calculated as the antilogarithm of the arithmetic mean of the logarithms of the data.
[23] The use of smolts/redd would result in a greater precision in the estimate of productivity. This increased precision may affect the timeframe to determine recovery.

1.5.3 Spatial Structure

This plan will identify actions that if implemented should vastly improve widespread or complex spatial structures of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. This will be accomplished by not destroying habitat (or their functions) at rates faster than they are created or restored, by not artificially increasing or decreasing natural rates of straying, by maintaining suitable habitats (major and minor spawning areas; see Section 4) even if they contain no ESA-listed species, by maintaining and increasing source populations[24], and by addressing man-made (artificial) barriers to fish migration and movement.

1.5.4 Diversity

Actions implemented under this plan will maintain both phenotypic (morphology, behavior, and life-history traits) and genotypic (genetic) within-population diversity. This will be accomplished by carefully managing and/or minimizing factors (e.g., introduction of non-native species, artificial propagation, hydropower reservoir effects, man-made barriers, and harvest pressures) that alter variation in traits such as run timing, age structure, size, fecundity, morphology, behavior, and molecular genetic characteristics.

In some cases, the mixing of hatchery fish (or excessive numbers of out-of-basin stocks) with naturally produced fish on spawning grounds can actually decrease genetic diversity within a population (Hallerman 2003). According to the ICBTRT (2005a), diversity of naturally produced populations, ESUs and DPSs can decrease because of hatchery adaptations of domestication, losses of genetic variability through supportive breeding, and erosion of natural population structure through homogenization. Recovery actions should be designed to reduce domestication and homogenization, and prevent gene flow rates greater than natural levels.

Importantly, historic (pre-development) diversity cannot be measured for any populations within the Upper Columbia Basin. Because spatial structure is the physical process that drives diversity, the two (spatial structure and diversity) are very difficult to separate (ICBTRT 2004). Therefore, following the recommendations of the ICBTRT (2004b), this plan will evaluate spatial structure and diversity together.

1.6 Overall Strategy to Recovery

This plan is based on the best empirical information currently available and professional judgment. In order to keep this plan simple and succinct, other documents have been referenced, and tangential or irrelevant information reduced to a minimum. For those interested in detailed information, please refer to the reference section of this document for a list of source materials. This plan is based on the information in those documents and some expanded analyses (e.g., EDT analysis for the Wenatchee Subbasin). The logic path used to develop the plan is shown in **Figure 1.6** and discussed briefly below.

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[24] This will follow the concept of metapopulation theory. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them. Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events (USFWS 2002).

The process of developing this plan began with identification of priority or focal species—spring Chinook, steelhead, and bull trout—based on ESA listings. Next, "independent" and "core" populations were identified based on the work of the ICBTRT (2003) and USFWS (2002) and the spatial structure of each population was then divided into geographic assessment units. Current and historical conditions of each population were described, with emphasis on VSP parameters (described above and in Section 4), and limiting factors that led to the decline of each population in the Upper Columbia Basin were identified. Appropriate actions were then selected that addressed limiting factors or threats[25] to listed fish populations in the Upper Columbia Basin.

Recommended actions addressed the most important limiting (primary) factor(s) and threats within each assessment unit and population. For each H (Harvest, Hatcheries, Hydropower, and Habitat), actions were linked to specific limiting factors. Using All H Analyzer, empirical and derived data, public input, and professional judgment, an assessment was completed of the cumulative effects of recovery actions integrated across the Hs and across populations. Importantly, actions will be coordinated with local stakeholders and jurisdictions that determined the feasibility of the recommended actions.

The process for selecting actions differed for each of the four Hs. Harvest actions were selected based on the best available science and from frameworks of legal authorities (e.g., ***U.S. v Oregon***). Hatchery actions were selected based on the best available science and from existing hatchery and genetic management plans (HGMPs), Biological Opinions, and the HCPs. Hydropower actions were selected primarily from existing HCPs and other processes (e.g., 2004 Federal Columbia River Power System Biological Opinion). Habitat actions were selected from other plans (e.g., NPCC subbasin plans, watershed plans, Wy-Kan-Ush-Mi Wa-Kish-Wit [Spirit of the Salmon], The Tribal Fish Recovery Plan and the USFWS Bull Trout Draft Recovery Plan), EDT analysis, public input, and the best available science. Habitat actions identified in this plan will be refined based on input from local landowners and land managers. The last step in the process compared the benefits in VSP parameters associated with the recommended actions to the recovery criteria outlined by ICBTRT (2004b) and the USFWS (2002).

It is important to note that the list of recommended actions identified in this plan represent the first step of recovery implementation. The beneficial actions identified in this plan are believed to represent a sound approach based on available information and tools, and they address the range of known threats. However, uncertainty exists for many actions because of insufficient information.[26] This plan does not assume risk-free management actions with perfectly predictable results. Therefore, this plan will monitor or assess the outcomes of different recovery actions. The plan is "adaptive" in the sense that it will take this information, combined with cost estimates, and re-evaluate priorities and reasonable actions. The intent is to use the information as a means of selecting what actions will be sufficient for recovery. This plan is a "living

[25] Limiting factors and threats represent two different things. Limiting factors represent the environmental condition (e.g., warm water temperatures) that negatively affects the abundance, productivity, and survival of a population. Threats, on the other hand, represent the actions that cause limiting factors (e.g., removal of stream side vegetation, which reduces stream shading and increases stream temperatures).
[26] Uncertainty of outcomes arises from a lack of knowledge about the ecological and social processes that affect fish as well as from stochastic (random) events.

document" that will be updated as new information becomes available. All significant modifications, especially those that change the regulatory environment or propose additional costs or restrictions on private property and water rights, shall be submitted for public review and comment by local governments and stakeholders, and approved by the UCSRB before implementation.

1.7 Relationship to Other Recovery Activities

There are a number of conservation and watershed planning efforts in varying stages of development and implementation that directly or indirectly protect or improve the viability of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. These efforts each have unique attributes, but may not meet all statutory requirements for the contents of recovery plans, as described in section 4(f)(1)(B) of the ESA including:

> (i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria, which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

Efforts currently being developed or implemented in the Upper Columbia Basin are identified in Section 7.

1.8 Coordination and Public Involvement

The three counties in the Upper Columbia Salmon Recovery Board developed similar public participation plans that are customized for the unique qualities of each county. These plans are designed to allow the community to learn about, and participate in, the processes to discuss documents and activities and elicit feedback from stakeholders regarding the design and implementation of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. Methods for soliciting public involvement may include, but are not limited to, public meetings, open houses, workshops, informational sessions, brochures, advisory committees, use of websites, and of course the documents themselves. Each county shares resources, ideas, and some of the regional commonalities to provide a coordinated and cost-effective means of public participation.

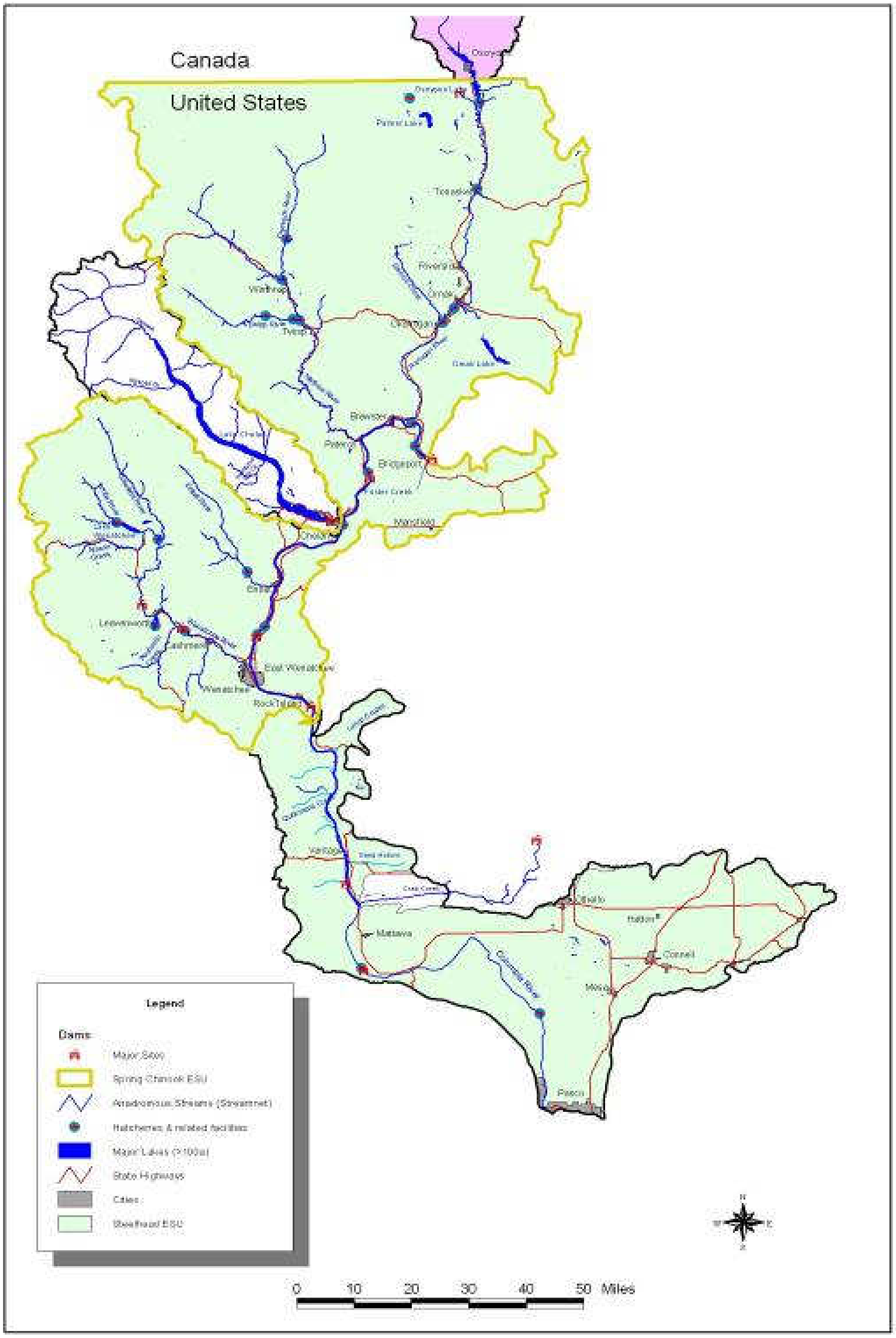

Figure 1.1 Subbasins and major tributaries within the Upper Columbia River Subbasin

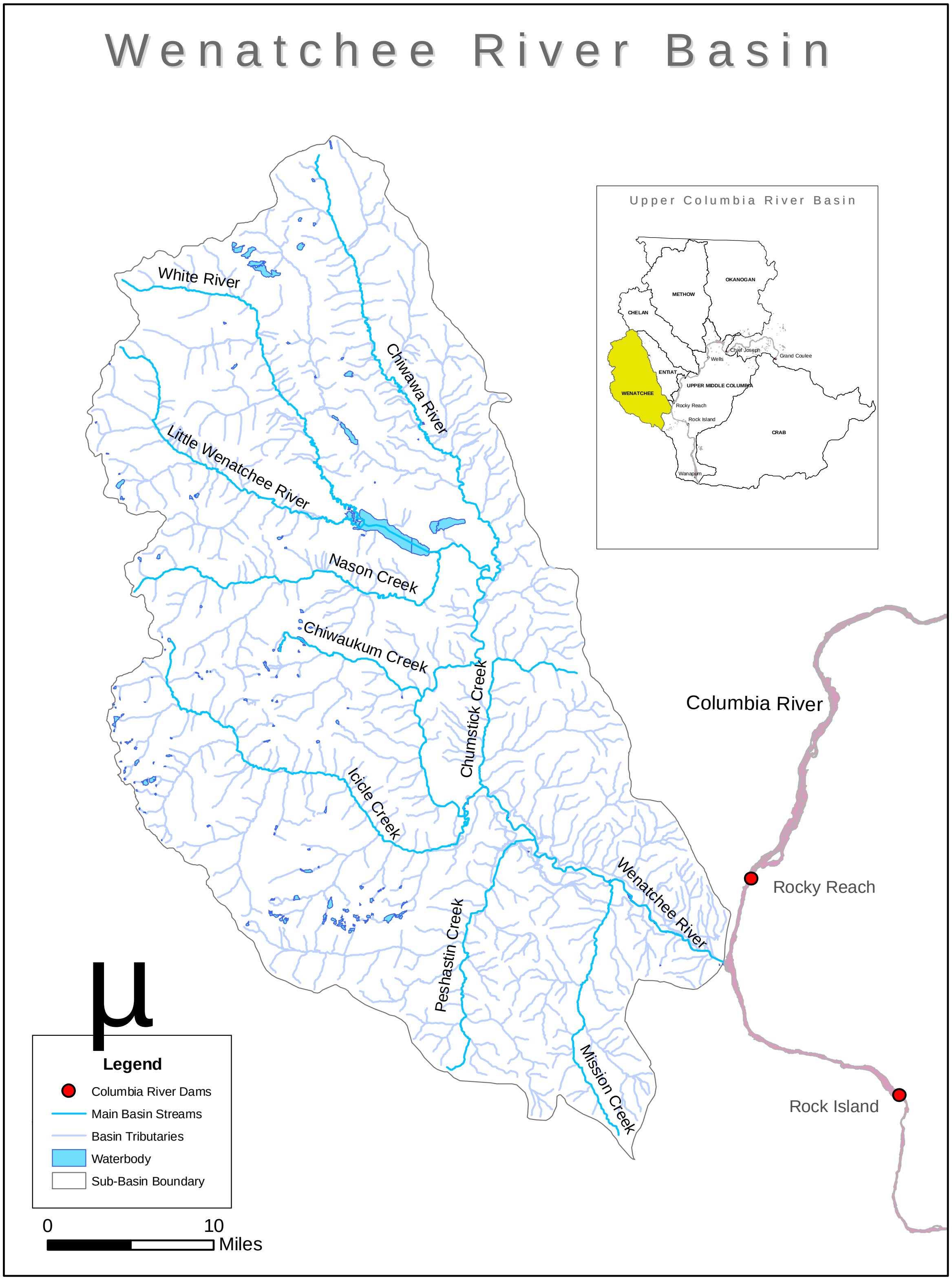

Figure 1.2 Major tributaries within the Wenatchee subbasin

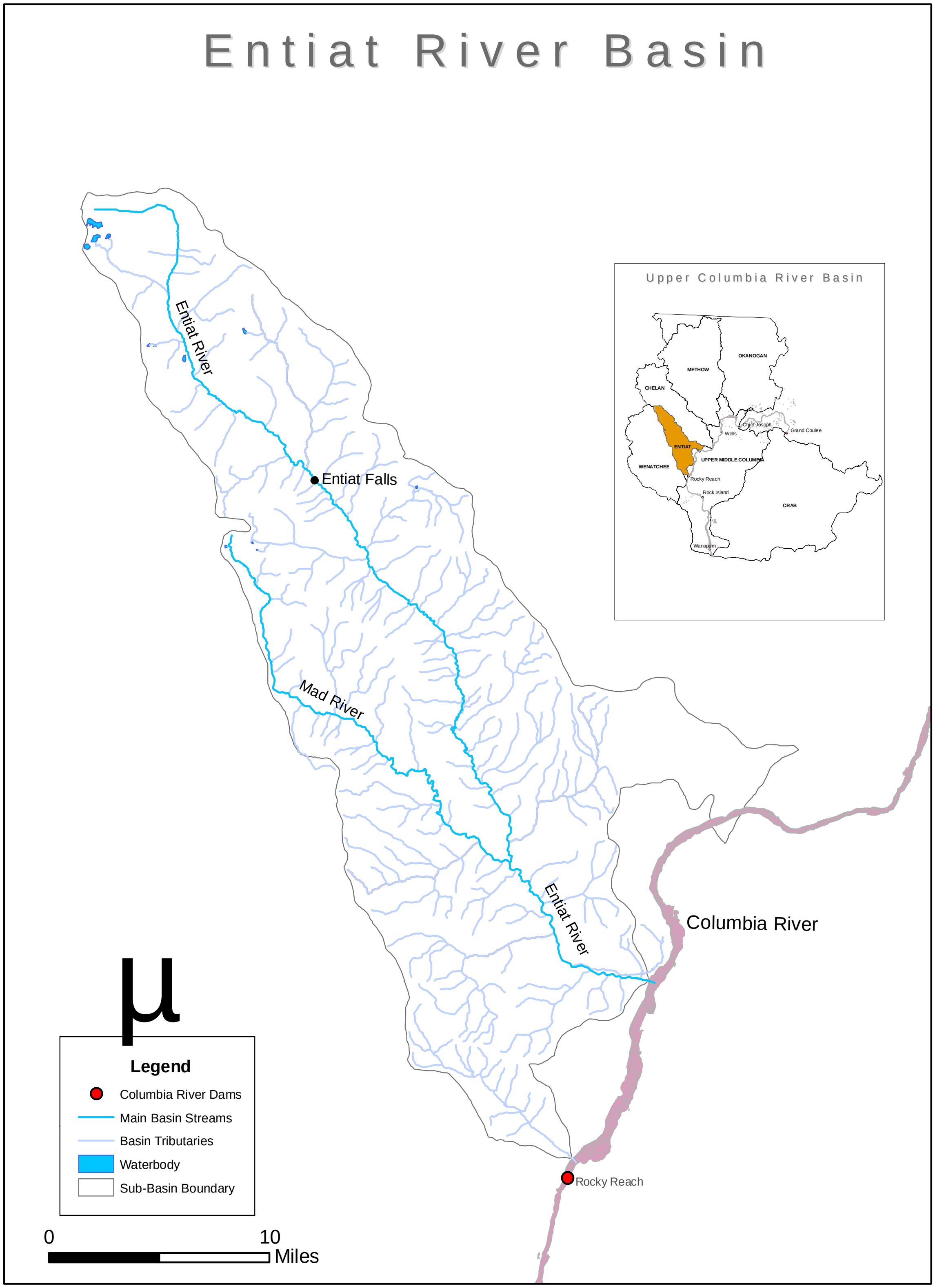

Figure 1.3 Major tributaries within the Entiat subbasin

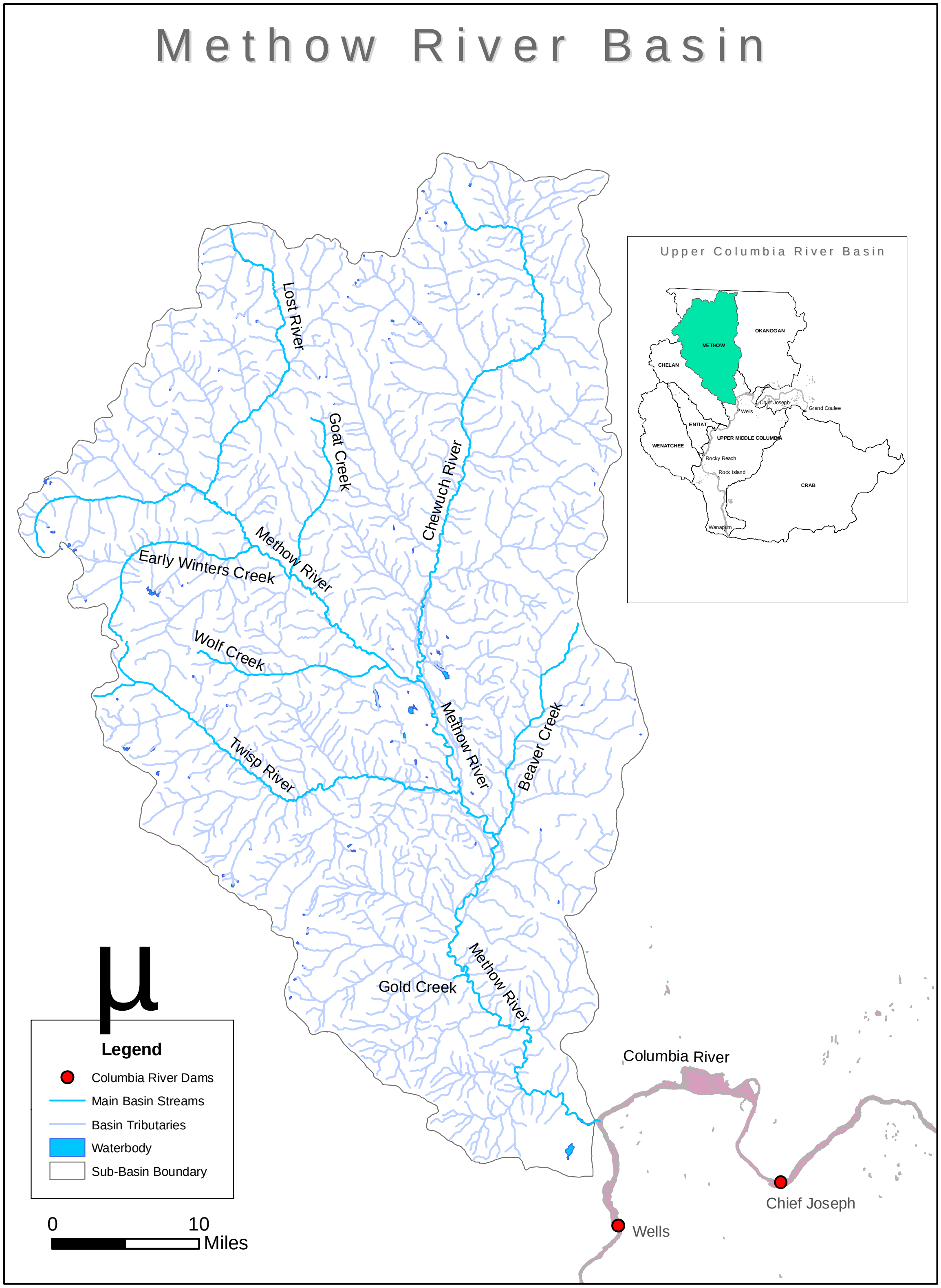

Figure 1.4 Major tributaries within the Methow subbasin

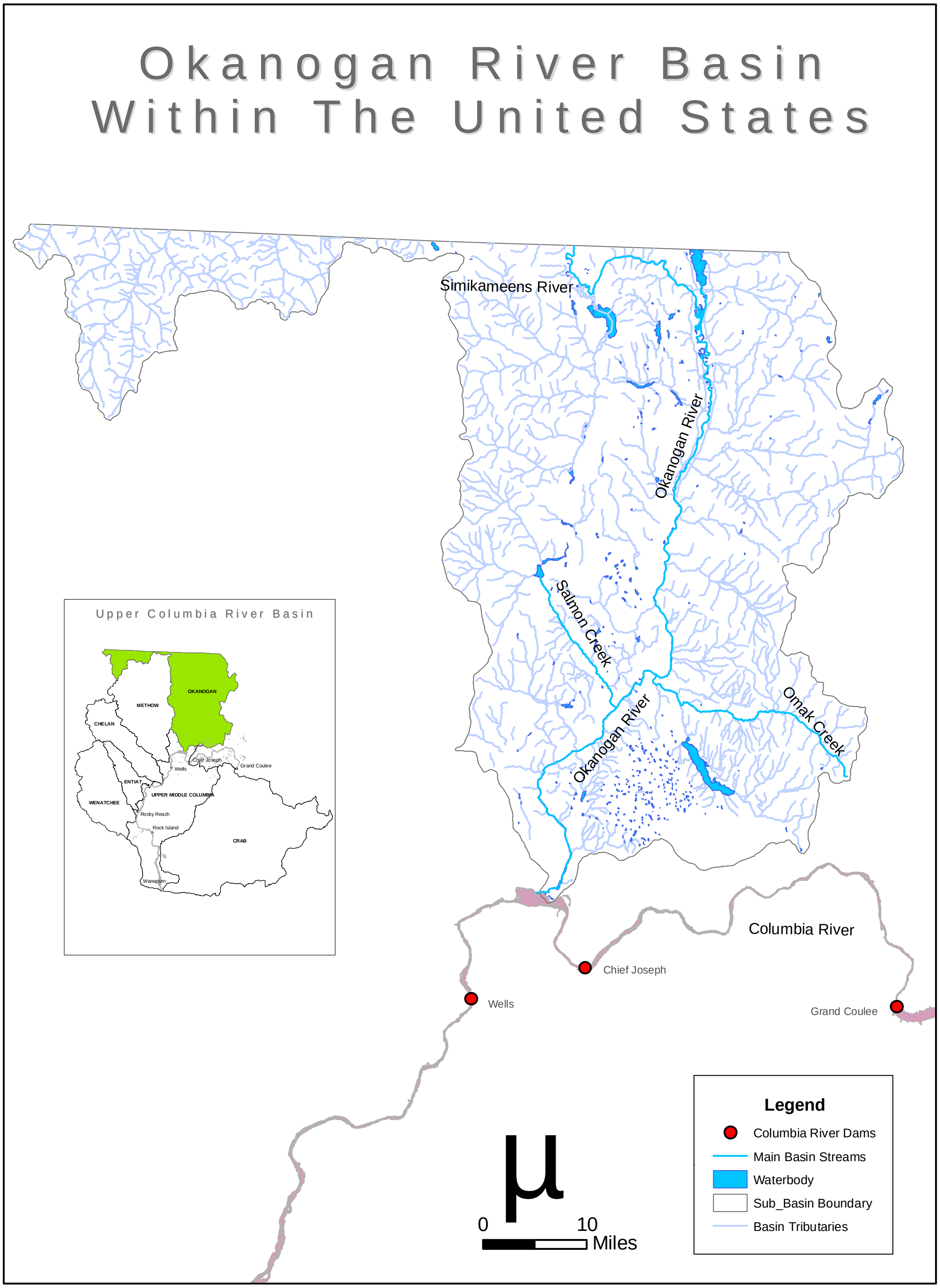

Figure 1.5 Major tributaries within the Okanogan subbasin

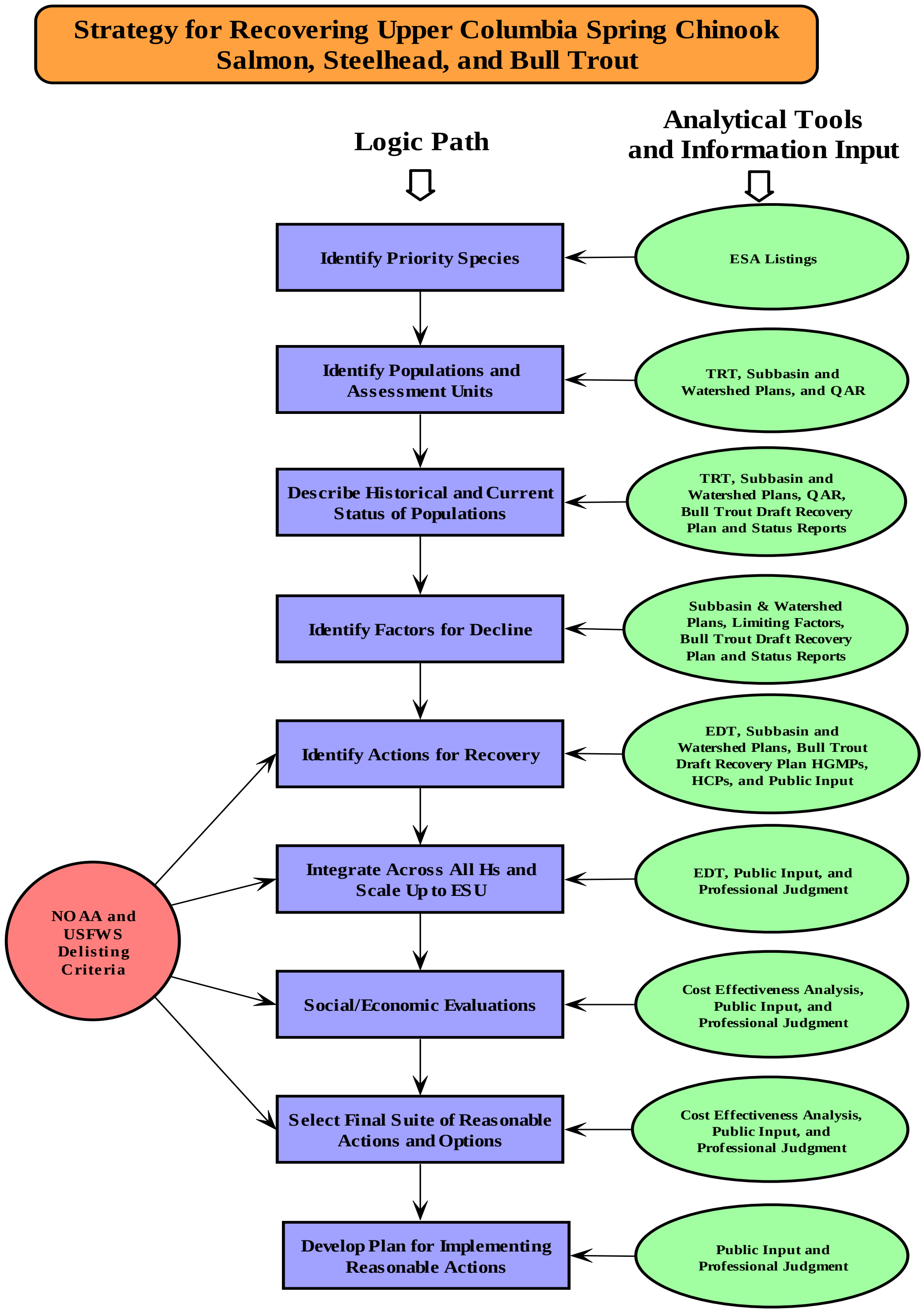

Figure 1.6 Logic path, analytical tools, and information sources used to develop the Upper Columbia Basin recovery plan

2 Species Status

This section briefly describes the community structure, current and historical population structure and life histories of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Data are available and presented in this section going back as far as 1960. Because variability in climate and ocean conditions can have very long cycle times, it is difficult to assess long-term variability in salmonid population structure in the Upper Columbia with high precision, given the limited number of years for which data are available. This section describes current and historic population structure by addressing the VSP parameters, abundance, productivity, spatial structure, and diversity, for each species and population. Readers can find a more detailed discussion on species status in the Upper Columbia Basin NPCC subbasin plans, watershed plans, and the USFWS Bull Trout Draft Recovery Plan.

2.1 Identification of Priority Species

2.1.1 Method for Selecting Priority Species

This recovery plan focuses on spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. These species were selected based on their status under the ESA. Upper Columbia spring Chinook and steelhead are listed as endangered under the ESA, while bull trout are listed as threatened.

2.1.2 General Life Histories of Priority Species

Spring Chinook

Spring Chinook in the Upper Columbia Basin have similar life-history characteristics to spring Chinook runs originating in the Snake River system (Chapman et al. 1995). Adults begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook enter the Upper Columbia tributaries from April through July. After migration, they hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid to late August. Juvenile spring Chinook spend a year in freshwater before migrating to salt water in the spring of their second year of life. Most Upper Columbia spring Chinook return as adults after two or three years in the ocean. Some precocious males, or jacks, return after one winter at sea. A few other males mature sexually in freshwater without migrating to the sea. However, four and five year old fish that have spent two and three years at sea, respectively, dominate the run. Fecundity ranges from 4,200 to 5,900 eggs, depending on the age and size of the female.

Steelhead

The life-history pattern of steelhead in the Upper Columbia Basin is complex (Chapman et al. 1994). Adults return to the Columbia River in the late summer and early fall. Unlike spring Chinook, most steelhead do not move upstream quickly to tributary spawning streams (K. Williams, personal communication). A portion of the returning run overwinters in the mainstem reservoirs, passing over the Upper Columbia River dams in April and May of the following year. Spawning occurs in the late spring of the calendar year following entry into the river. Currently, and for the past 20+ years, most steelhead spawning in the wild are hatchery fish. Juvenile steelhead generally spend one to three years rearing in freshwater before migrating to the ocean, but have been documented spending as many as seven years in freshwater before migrating (Peven 1990; Mullan et al. 1992). Most adult steelhead return to the Upper Columbia after one or two years at sea. Steelhead in the Upper Columbia have a relatively high fecundity, averaging between 5,300 and 6,000 eggs (Chapman et al. 1994).

Steelhead can residualize (lose the ability to smolt) in tributaries and never migrate to sea, thereby becoming resident rainbow trout. Conversely, progeny of resident rainbow trout can migrate to the sea and thereby become steelhead. Despite the apparent reproductive exchange between resident and anadromous ***O. mykiss***, the two life forms remain separated physically, physiologically, ecologically, and behaviorally (70 FR 67130). Steelhead differ from resident rainbow physically in adult size and fecundity, physiologically by undergoing smoltification, ecologically in their preferred prey and principal predators, and behaviorally in their migratory strategy. Given these differences, NMFS (70 FR 67130) proposed that the anadromous steelhead populations are discrete from the resident rainbow trout populations. Therefore, this plan only addresses the recovery of anadromous steelhead. Resident rainbow trout are not included in the recovery of steelhead.

Bull Trout

Bull trout in the Upper Columbia Basin exhibit both resident and migratory life-history strategies (USFWS 2002). Some of the populations also exhibit such strategies as every year and every other year spawning as well as offsetting migration periods. Bull trout migrate to spawning areas as well as rearing/feeding areas (Kelly-Ringel, USFWS, personal communication). Migrations may occur between core areas and within the Columbia River (BioAnalysts 2002, 2003). Resident bull trout complete their entire life cycle in the tributary stream in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form) or river (fluvial form). Migrating bull trout have been observed within spawning tributaries as early as the end of June, while spawning occurs in mid-September to late October/early November. Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993).

The size and age of bull trout at maturity depends upon life-history strategy. Resident fish tend to be smaller than migratory fish at maturity and produce fewer eggs. BioAnalysts (2002) compared a sample of resident and fluvial fish from the Methow subbasin and found that the fluvial fish were two to three times larger than resident fish of the same age. Bull trout usually reach sexual maturity in four to seven years and may live longer than 12 years (Fraley and Shepard 1989; Williams and Mullan 1992). Repeat-spawning frequency and post-spawning mortality are not well documented in the Upper Columbia Basin.

Bull trout distribution is limited by water temperature above 15°C, which may partially explain their patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995; Dunham et al. 2003). Bull trout spawn in the fall typically in cold, clean, low-gradient streams with loose, clean gravel (Fraley and Shepard 1989; Rieman and McIntyre 1993). Bull trout at all life stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Watson and Hillman 1997; Rich et al. 2003). Bull trout exhibit some differences from salmon in that they are in the habitat in the Upper Columbia Basin year round and can remain in the gravel for up to 220 or more days (USFWS 1998). They are susceptible to competition by other non-native char such as brook trout and lake trout.

2.1.3 Other Species of Importance

Other species of importance within the Upper Columbia Basin include summer Chinook, sockeye salmon (***O. nerka***), Pacific lamprey (***Lampetra tridentata***), white sturgeon (***Acipenser transmontanus***), and westslope cutthroat trout (***O. clarki lewisi***). Currently, Pacific lamprey and westslope cutthroat are designated as species of concern (USFWS 2005). NOAA Fisheries reviewed the status of summer Chinook and sockeye salmon and concluded that their relative abundances did not warrant listing and that they do not appear to be endangered in the future (59 FR 48855; 63 FR 11751). NOAA Fisheries did suggest, however, that the two populations of sockeye within the Upper Columbia Basin should be monitored because of their potential to become threatened (64 FR 14528). The USFWS reviewed the status of westslope cutthroat and determined that they were not warranted for listing (68 FR 46989); however, they are still designated as species of concern. Recovery actions identified under this plan are expected to benefit all these species, as well as spring Chinook, steelhead, and bull trout.

2.2 Community Structure

Spring Chinook, steelhead, and bull trout share the aquatic environment with several other fish species in the Upper Columbia Basin. Available information (summarized in Hillman 2000; Duke Engineering 2001; subbasin plans 2005) indicates that about 41 species of fish occur within the Upper Columbia Basin (from the mouth of the Yakima River upstream to Chief Joseph Dam) (Appendix A). This is an underestimate because several species of cottids (sculpins)[27] live there. Of the fishes in the basin, 15 are cold-water species, 18 are cool-water species, and 8 are warm-water species. Most of the cold-water species are native to the area; only five were introduced (brown trout (***Salmo trutta***), brook trout (***S. fontinalis***), lake whitefish (***Coregonus clupeaformis***), lake trout (***S, namaycush***), and Atlantic salmon (***S. salar***)). Four of the 18 cool-water species are introduced (pumpkinseed (***Lepomis gibbosus***), walleye (***Stizostedion vitreum***), yellow perch (***Perca flavescens***), and smallmouth bass (***Micropterus dolomieu***)), while all warm-water species in the Upper Columbia Basin are introduced.

Anadromous species within the upper basin include spring and summer Chinook salmon, coho salmon (***O. kisutch***), sockeye salmon, steelhead, and Pacific lamprey. White sturgeon, which may have been anadromous historically, are present as a resident population. These fish are rarely detected migrating upstream at Upper Columbia River dams.

About half of the resident species in the upper basin are piscivorous (eat fish) (Appendix A). Ten cold-water species, seven cool-water species, and five warm-water species are known to eat fish.

[27] At least three species of sculpins have been identified in the Upper Columbia Basin. They include Prickly sculpin (***Cottus asper***), torrent sculpin (***C. rhotheus***), and shorthead sculpin (***C. confuses***).

About 59% of these piscivores are exotics. Before the introduction of exotic species, northern pikeminnow (***Ptychocheilus oregonensis***), sculpin (***Cottus*** spp.), white sturgeon, bull trout[28], rainbow trout, cutthroat trout, and burbot (***Lota lota***) were the primary piscivores in the region (Li et al. 1987; Poe et al. 1994). Presently, burbot are rare in the upper basin (Dell et al. 1975; Burley and Poe 1994) and probably have little effect on the abundance of ESA-listed species in the region. The status of white sturgeon in the Upper Columbia Basin is mostly unknown, although their numbers appear to be quite low (DeVore et al. 2000).

2.3 Population Characteristics and Life Histories

2.3.1 Levels of Population Structure

Before describing the population structure of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin, it is important to define the different levels of population structure. Various terms have been used to define levels of population structure or ecological types. Brannon et al. (2002) stated that population structure is defined by the life-history strategies that have evolved to maximize fitness under varying environmental conditions within geographic ranges. Identified below are the levels of population structure used in this plan.

Distinct Population Segment

As amended in 1978, the ESA allows listing of distinct population segments (DPSs) of vertebrates as well as named species and subspecies. However, the ESA did not provide specific guidance on what constituted a DPS, and thus created some ambiguity (Platts et al. 1993). Because of this ambiguity, NOAA Fisheries and the USFWS created a policy in 1996 to recognize and define DPSs in relation to ESA listings (61 FR 4722). Because NOAA Fisheries had established a policy in 1991 that defined species under the ESA (56 FR 58612) for Pacific salmonids, it maintained its delineation for the ESA that a population segment would be a DPS if it were an ESU.

The USFWS requested that NMFS consider departing from use of the ESU Policy and evaluate ***O. mykiss*** population risk status through the DPS Policy. The major difference between the two policies is that under the ESU Policy, one delineation of whether a population is distinct is that they are "reproductively isolated" from other population segments. Within the DPS Policy, there only needs to be "marked separation" to satisfy population distinctiveness.

Evolutionarily Significant Units

Waples (1991) defined ESUs as the determining population structure for delineating whether a "species" should be listed under the ESA. An ESU is a population (or group of populations) that (1) is reproductively isolated from other related population units and (2) represents an important component in the evolutionary legacy of the species. ESUs may contain multiple populations that

[28] The recovery of ESA-listed species that prey on other ESA-listed species (e.g., bull trout that prey on juvenile spring Chinook and steelhead) may appear to be counter productive. However, the recovery levels established in this plan for bull trout will not prevent the recovery of the other listed species. The three ESA-listed species evolved together in the Columbia Basin and their niches are sufficiently segregated to prevent one species from driving the others to extinction. Large bull trout are generalists and will not prey exclusively on spring Chinook and steelhead.

are connected by some degree of migration, and hence may have broad geographic areas, transcending political borders. Determining exactly what the evolutionary significance of a population is may be difficult.

Independent Populations

Following McElhany et al. (2000), the ICBTRT (2003) defined independent populations, as:

> …a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season. For our purposes, not interbreeding to a 'substantial degree' means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame.

Core Areas

The USFWS (2002) defined a core area to be the closest approximation of a biologically functioning unit that reflects the metapopulation structure of bull trout as described by Dunham and Rieman (1999). That is, within the metapopulation or core areas, local populations are expected to function as one demographic unit. Thus, a core area may consist of one or more local populations. Rieman and Allendorf (2001) have suggested that between 5 and 10 populations are necessary for a bull trout metapopulation to function effectively. Core areas are not necessarily synonymous with independent populations. Bull trout may be grouped so that they share genetic characteristics as well as management jurisdictions (USFWS 2002). The USFWS is in the process of collecting and analyzing genetic data from all three core areas in the Upper Columbia. The results may clarify the extent of interbreeding between local populations and core areas.

As noted earlier, this recovery plan will focus on actions that, if implemented, should improve the VSP parameters of ESA-listed species at the "population" and "core area" level.

2.3.2 Historic Population Characteristics

Chapman (1986) stated that large runs of Chinook and sockeye, as well as smaller runs of coho, steelhead, and chum (***O. keta***) historically (pre-development) returned to the Columbia River. Chum used the lower Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, Chapman (1986) estimated pre-development run sizes of about 588,000 spring Chinook, 3.7 million summer Chinook, 554,000 steelhead, over 2.6 million sockeye, 618,000 coho, and 748,000 chum for the entire Columbia Basin. Spring Chinook, summer Chinook, steelhead, sockeye, and coho were relatively abundant in Upper Columbia River tributary streams before extensive resource exploitation (e.g., harvest, logging, mining, dams and diversions, and agriculture) in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid- and upper-Columbia River spring and summer Chinook runs (McDonald 1895), and eventually steelhead, sockeye, and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). It was estimated that at the time Grand Coulee Dam was built that 85 to 90%

of the fish counted at Rock Island Dam from 1933-1937 originated from spawning areas upstream from Grand Coulee Dam (Calkins et al. 1939).

Upper Columbia Spring Chinook

The Upper Columbia spring Chinook ESU includes three extant populations (Wenatchee, Entiat, and Methow), as well as one extinct population in the Okanogan subbasin (ICBTRT 2003).

Wenatchee

Abundance

Mullan et al. (1992) estimated that the total historic Chinook run to the Wenatchee was about 41,000 fish. It is unknown what fraction of this estimate represents spring Chinook.

Productivity

While there are no quantitative data on historic productivity in the Wenatchee subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b). Populations with growth rates greater than 1.0 are resilient to negative environmental conditions and can quickly rebound from low abundances. The ICBTRT (2005a) assumed that all historic populations had productivities of 1.0 or greater when populations were well below carrying capacity, and, even at high densities, expressed long-term mean returns-per-spawner greater than 1.0.

Spatial structure and diversity

Fulton (1968) described the distribution of spring Chinook in the Wenatchee subbasin as most of the main river; portions of the Chiwawa, Little Wenatchee, and White rivers, and Nason, Icicle, and Peshastin creeks. Salmonscape (http://wdfw.wa.gov/mapping/salmonscape/) and the intrinsic productivity analysis (NWFSC 2004) suggests that spring Chinook also occurred in Mission and Chiwaukum creeks.

Entiat

Abundance

Mullan et al. (1992) estimated that the total Chinook run in the Entiat was 3,400 historically. Because summer Chinook probably did not use the Entiat (Fish and Hanavan 1948; Mullan 1987), the entire estimate probably represents the historic abundance of spring Chinook.

Productivity

While there are no quantitative data on historic productivity in the Entiat subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1968) identified most of the mainstem Entiat as habitat for spring Chinook, noting that steep gradients of tributaries prevented salmon use there. Salmonscape and the intrinsic productivity analysis (NWFSC 2004) indicate that spring Chinook also used the lower five miles of the Mad River.

Methow

Abundance

The historic estimate for Chinook within the Methow subbasin was estimated by Mullan et al. (1992) as just over 24,000 fish. It is unclear whether summer Chinook occupied the Methow River (Mullan 1987), thus a large fraction of this estimate was probably spring Chinook.

Productivity

While there are no quantitative data on historic productivity in the Methow subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1968) described the historic distribution of spring Chinook in the Methow subbasin as the mainstem Methow River and larger tributaries, including the lower portion of the Twisp River and the mainstream of the Chewuch River to a point 52 km upstream from the mouth. Fulton (1968) also mentioned that the Chewuch River had the largest spring Chinook run of any single stream upstream from Rocky Reach Dam. Salmonscape also includes Gold, Wolf, and Early Winters creeks and the Lost River as potential historic habitat for spring Chinook.

Okanogan

Abundance

Although spring Chinook occurred in the Okanogan subbasin historically (Vedan 2002), there are no estimates of their abundance in the subbasin. Their abundance was likely small, however, because of a lack of suitable habitat in the Okanogan subbasin.[29] An assumption by the ICBTRT (2003) is that all historic populations consisted of at least 500 fish. Therefore, this plan assumes that the Okanogan had the capacity for at least 500 spring Chinook.[30]

Productivity

While there are no quantitative data on historic productivity in the Okanogan subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

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[29] Williams (personal communication) speculates that spring Chinook spawned and reared only in the Canadian portion of the Okanogan subbasin.
[30] The minimum abundance criterion of 500 fish per population is based on theoretical and limited empirical information provided by the ICBTRT. The use of this criterion in the Upper Columbia Basin has not been demonstrated with empirical data. Therefore, this criterion may change as more information is gathered (through monitoring) within the Upper Columbia Basin.

Spatial structure and diversity

Craig and Suomela (1941) contain affidavits that indicate spring Chinook historically used Salmon Creek and possibly Omak Creek. In 1936, spring Chinook were observed in the Okanogan River upstream from Lake Osoyoos by Canadian biologists (Gartrell 1936).[31] Vedan (2002) contains information suggesting that spring Chinook historically entered Okanogan Lake and ascended upstream past Okanogan Falls. Spring Chinook in the Okanogan subbasin may have exhibited a lake-rearing life-history trait (S. Smith, personal communication).

There is no evidence that spring Chinook (or steelhead) used the Similkameen River upstream from falls that lay at the present site of Enloe Dam (Chapman et al. 1995). Cox and Russell (1942) state:

> From testimony of a Mr. McGrath at Nighthawk, who had been in that country over 40 years, we learned that before any power dam was built (Enloe Dam), the 15' to 20' natural falls already mentioned prevented salmon ascending any farther. He had often fished the river at Nighthawk but had never heard of a salmon being seen or caught above the natural falls. He stated that the Indians came in to fish at these falls each summer...Therefore, we conclude that this power dam did not interfere with any salmon runs...

Accounts from Native American oral tradition (i.e., the story of coyote) suggest that salmon never passed upstream of the falls, and the Native people of the Similkameen valley never sought to have fish passage there, further confirming that anadromous fish never passed the falls (Vedan 2002). The lack of anadromous fish upstream from the falls is further supported by the work of Copp (1998), who researched the plant and animal resources of the Similkameen drainage and concluded that anadromous fish did not occur in the Canadian portion of the Similkameen drainage.

Upper Columbia Steelhead

The Upper Columbia steelhead DPS includes five extant populations (Wenatchee, Entiat, Methow, Okanogan, and Crab Creek[32]) (ICBTRT 2003). Calkins et al. (1939) estimated that 85-90% of the Chinook, steelhead, and sockeye counted at Rock Island Dam in the 1930s were destined for areas upstream of Grand Coulee Dam. Other estimates are available from Scholz et al. (1985).

Small Tributaries of the Columbia River

Howell et al. (1985) noted that several smaller tributaries of the Columbia River, such as Squilchuck, Stemilt, Colockum, Tarpiscan, Brushy, Tekison, Foster, and Quilomene creeks,

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[31] Gartrell (1936) contains the only reference that we found to spawning by spring-run Chinook salmon in the main Okanogan River. We regard this information cautiously.

[32] As noted in the Section 1, this plan does not address specific recovery actions for the Crab Creek steelhead population.

potentially produced steelhead, but never in great numbers.[33] Steelhead probably also used Crab Creek (see Upper Middle Mainstem Subbasin Plan 2004 and Crab Creek Subbasin Plan 2005).

Wenatchee

Abundance

Mullan et al. (1992; their table 5) estimated that the steelhead run to the Wenatchee was about 7,300 fish.

Productivity

While there are no quantitative data on historic productivity in the Wenatchee subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1970) identified lower Mission, Peshastin, Icicle, Chiwaukum, Chumstick, Beaver, and Nason creeks, and the Wenatchee, Chiwawa, Little Wenatchee, and White rivers as historical steelhead habitat. Salmonscape also included Derby Creek, and numerous small tributaries, within the above-mentioned watersheds as historical steelhead habitat.

Entiat

Abundance

Mullan et al. (1992; their table 5) estimated that the historic run of steelhead in the Entiat was 500 fish.

Productivity

While there are no quantitative data on historic productivity in the Entiat subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1970) listed the mainstem Entiat and Mad rivers as historical steelhead streams. Salmonscape also includes the lower portions of Mud, Potato, Stormy, Tillicum, and Roaring creeks.

Methow

Abundance

Mullan et al. (1992; their table 5) estimated that the historic run of steelhead in the Methow was about 3,600 fish.

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[33] Steelhead in small tributaries downstream from the Wenatchee River are part of the Wenatchee steelhead population (ICBTRT 2004).

Productivity

While there are no quantitative data on historic productivity in the Methow subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1970) lists the mainstem, Twisp, and Chewuch rivers, and lower Beaver Creek as historic steelhead habitat. WDF/WDW (1992) also listed Gold, Wolf, and Early Winters creeks, and the Lost River, as historic steelhead habitat. Salmonscape includes Little Bridge, Lake, Eightmile, South Fork Gold, Libby, Smith Canyon, Black Canyon, Bear, and Goat creeks as historical steelhead streams. Williams (personal communication) noted that steelhead also occur in the lower portions of Cub, Falls, Twentymile, Boulder, South, Crater, War, Andrews, West and East Forks of Buttermilk, Rattlesnake, Reynolds, Robinson, Eureka, and Monument creeks.

Okanogan

Abundance

Numbers of steelhead are not available for the Okanogan subbasin. Mullan et al. (1992) indicated that steelhead in the Okanogan subbasin were not abundant, and that Salmon Creek and the lower Similkameen River (downstream of Enloe Falls) were the most probable steelhead producing streams in the subbasin. An assumption by the ICBTRT (2003) is that all historic populations consisted of at least 500 fish.

Productivity

While there are no quantitative data on historic productivity in the Okanogan subbasin, it is a basic assumption of defining a viable population that the population growth rate was greater than 1.0, meaning that on average more than one offspring returned for every fish that spawned (ICBTRT 2004b).

Spatial structure and diversity

Fulton (1970) identified Omak and Salmon creeks as steelhead-producing streams, and the upper Similkameen, but that is questioned based on uncertainty of fish being able to ascend Enloe Falls before construction of Enloe Dam at that site (Chapman et al. 1994). Steelhead also ascended the Okanogan River into Canada (Vedan 2002).

Upper Columbia Bull Trout

The Upper Columbia bull trout recovery area includes three core areas (Wenatchee, Entiat, and Methow), the mainstem Columbia River, and two areas designated as “unknown occupancy” (Lake Chelan and Okanogan) (USFWS 2002).

Wenatchee

Abundance

There are no estimates of the historical abundance of bull trout in the Wenatchee subbasin.

Productivity

There are no data available to describe historical production of bull trout in the Wenatchee subbasin. It is assumed that bull trout historically maintained stable trends over time.

Spatial structure and diversity

It is believed that bull trout historically occurred throughout most drainages within the Wenatchee subbasin. They occurred within the Chiwawa, White, Little Wenatchee, Nason, Chiwaukum, Icicle, and Peshastin Creek drainages and in the Wenatchee River (USFWS 2002). There is no evidence that they occurred in the Chumstick or Mission Creek drainages. All life-history forms (resident, fluvial, and adfluvial) occurred in the Wenatchee subbasin historically (USFWS 2002; K. Williams, personal communication).

Entiat

Abundance

There are no estimates of the historical abundance of bull trout in the Entiat subbasin.

Productivity

There are no data available to describe historical production of bull trout in the Entiat subbasin. It is assumed that bull trout historically maintained stable trends over time.

Spatial structure and diversity

Bull trout historically occurred in the Entiat River upstream to Entiat Falls[34] and in the Mad River. Both resident and fluvial forms of bull trout probably occurred in the Entiat subbasin (USFWS 2002).

Methow

Abundance

There are no estimates of the historical abundance of bull trout in the Methow subbasin.

Productivity

There are no data available to describe historical production of bull trout in the Methow subbasin. It is assumed that bull trout historically maintained stable trends over time.

Spatial structure and diversity

Historically, bull trout occurred throughout most of the subbasin including Gold, Wolf, Early Winters, Trout, Beaver, Lake, Buttermilk, and Goat creeks, and the Twisp, Chewuch, Upper Methow, and Lost rivers (USFWS 2002). Based on habitat conditions, they may have also occurred in Little Bridge, Eightmile, Libby, Smith Canyon, Black Canyon, and Bear creeks. Both resident, fluvial, and adfluvial forms of bull trout occurred in the Methow Basin historically (USFWS 2002).

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[34] It is unknown if bull trout existed upstream from the falls. Currently, numerous non-native brook trout exist upstream from the falls.

Lake Chelan

Abundance

There are no estimates of the historical abundance of bull trout in the Lake Chelan subbasin.

Productivity

There are no data available to describe historical production of bull trout in the Lake Chelan subbasin. It is assumed that bull trout historically maintained stable trends over time.

Spatial structure and diversity

It is quite likely that resident life-history types as well as known adfluvial bull trout occurred historically in the Lake Chelan subbasin. Based on summaries in Brown (1984), adfluvial bull trout historically occurred in the Stehekin drainage and its major tributaries, Bridge, Flat, Agnes, Blackberry, and Company creeks. Other streams that may have supported bull trout at least in their deltas included Mitchell, Gold, Grade, Safety Harbor, Prince, Fish, Four Mile, Railroad, Deep Harbor, Big, Little Big, Twentyfive Mile, and First creeks (Brown 1984). The adfluvial component has not been observed since 1951 (Brown 1984) and the status of the resident form is unknown. Fluvial bull trout have been observed in the lower Chelan River (BioAnalysts, Inc. 2003).

Okanogan

Abundance

There are no estimates of the historical abundance of bull trout in the Okanogan subbasin.

Productivity

There are no data available to describe historical production of bull trout in the Okanogan subbasin. It is assumed that bull trout historically maintained stable trends over time.

Spatial structure and diversity

The historical distribution of bull trout in the Okanogan subbasin is not well known. It is believed that they occurred in at least Salmon and Loup Loup creeks (Fisher and Wolf 2002; Williams, personal communication) and in the Okanogan River.[35] It is possible that both resident and migrant (fluvial and adfluvial) forms occurred in the Okanogan subbasin.

2.3.3 Current Population Characteristics

This section describes the current abundance, productivity, spatial structure, and diversity of each population within the Upper Columbia Basin. Some VSP parameters, such as returns per spawner, are not available for recent years because not all fish from recent spawning

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[35] The Omak Chronicle (Vol. 4, No. 25, Nov. 7, 1913) reports P. Umbrite landing some “extra nice big Dolly Varden trout” from the bridge in Omak. The Chronicle also reports that O. E. Bisher landed “two fine specimens of the Dolly Varden trout” from the Okanogan River. An angler reported capturing an adult bull trout near the town of Mallot in early spring 2003 (C. Fisher, personal communication, Colville Tribes).

escapements have returned from the ocean. This section relies heavily on the information provided by NOAA Fisheries (T. Cooney, NOAA Fisheries, personal communication) and the Bull Trout Draft Recovery Plan (USFWS 2002).

This plan reports the 12-year geometric mean for abundance and productivity as the appropriate interval to measure current status of spring Chinook and steelhead. The twelve-year period falls within the recommended guidance of the ICBTRT (8-20 years) and represents two to three generations for spring Chinook and steelhead. The geometric mean provides a better indicator of central tendency than the arithmetic mean, which is often skewed by uncommon large and small returns. The geometric mean for productivity (returns per spawner) must be back calculated, based on run reconstruction, for five years previous to the most recent abundance estimate.

Upper Columbia Spring Chinook

Current (from 1960 to present) abundance and production for each population of spring Chinook in the Upper Columbia Basin were based on spawner estimates (spawning escapements) and returns per spawner (spawner to spawner return rates), respectively. Spawning escapement was based on numbers of redds, expanded by an estimated fish/redd ratio of 2.2 fish/redd.[36] Returns from each brood-year spawning escapement were estimated by run reconstruction based on age composition. Year-specific age-composition estimates were obtained from spawning ground surveys, tributary fishery samples, or corresponding hatchery returns. Returns from each spawning escapement were estimated by summing up the subsequent returns from each spawning escapement across the appropriate range of future years. See NOAA Fisheries website http://www.nwr.noaa.gov/Salmon-Recovery-Planning/index.cfm for a description of analytical methods, assumptions, and results.

Wenatchee

Abundance

From 1960 to 2003, abundance of age 3+ spring Chinook in the Wenatchee subbasin ranged from 51 to 6,718 fish (**Table 2.1**, **Figure 2.1**).[37] During this period the 12-year geometric mean of spawners in the subbasin ranged from 383 to 3,449 adults (**Table 2.1**, **Figure 2.1**). The geometric mean at the time of listing (1999) was 417 spawners.

[36] The number of adult fish per redd is calculated at the number of adult fish returning to the spawning grounds divided by the number of redds that they construct. The reason that the number per redd is often greater than 2 (one male and one female) is because some of the adults that return to the spawning grounds do not spawn (i.e., they die before spawning). Thus, the ratio provides an estimate of pre-spawn mortality. The ratio is useful in estimating total spawning escapement if only the number of redds is known (total escapement = ratio x number of redds).

[37] Out-of-basin Carson stock spawn primarily in Icicle Creek. Fish that spawned in Icicle Creek were not included in the abundance estimates. Any out-of-basin fish that spawned in other areas within the subbasin were included in the estimates, because there was no way to remove them from the returns.

Productivity

During the period 1960 to 1999, returns per spawner for spring Chinook in the Wenatchee subbasin ranged from 0.06 to 4.59 (**Table 2.1**,**Figure 2.1**). The 12-year geometric mean of returns per spawner during this period ranged from 0.31 to 1.19 (**Table 2.1**, **Figure 2.1**). The geometric mean at the time of listing (1999) was 0.74.

WDFW has estimated the freshwater productivity (smolts per redd) of spring Chinook in the Wenatchee subbasin for the period 1992-2002 (WDFW, unpublished data). Numbers of smolts and redds were estimated at three different spatial scales: Wenatchee subbasin, area upstream from Tumwater Canyon, and the Chiwawa basin. The geometric mean for the Chiwawa was 364 smolts/redd. The geometric mean for the area upstream of Tumwater Canyon was 250 smolts/redd, while the geometric mean for the total Wenatchee subbasin was 197 smolts/redd (**Figure 2.2**). These estimates are not independent, because estimates for the Chiwawa basin are included in the estimate for the area upstream from Tumwater Canyon, which are included in the total Wenatchee subbasin estimate. Habitat downstream of Tumwater Canyon is less productive than the upper watershed.

Spatial structure and diversity

Spring Chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer Chinook in that area (Peven 1994). The primary spawning areas of spring Chinook in the Wenatchee subbasin include Nason Creek and the Chiwawa, Little Wenatchee, and White rivers (**Figure 2.3**). During high abundance years, such as 2001, spring Chinook also spawn in Chiwaukum Creek. Beginning in 2001, the USFWS and the Yakama Nation (YN) planted Leavenworth (Carson stock) adult spring Chinook into Peshastin Creek. The outplanting was part of a study to determine if hatchery adult plants could be used to restore the spring Chinook population in Peshastin Creek. The last outplanting is scheduled for 2005. These fish are not part of the ESU. Spawning in Icicle Creek is from out-of-basin (non-listed) spring Chinook released from the Leavenworth National Fish Hatchery (Chapman et al. 1995).

After 1850, the diversity of the Wenatchee population was likely reduced because of hatchery programs, commercial harvest, and habitat degradation. The diversity of the Wenatchee population was also reduced in part because of the Grand Coulee Fish Maintenance Project (GCFMP) and hydropower development. The continued release of out-of-basin spring Chinook from the Leavenworth National Fish Hatchery may have some effect on the diversity of spring Chinook in the Wenatchee subbasin. Tagging studies indicate that stray rates are generally low (<1%) (Pastor 2004).[38] Recently, based on expanded carcass recoveries from spawning ground surveys (2001-2004), the straying from Leavenworth National Fish Hatchery and other out-of-basin facilities has accounted for 3-27% of the natural spawner composition upstream from Tumwater Canyon despite the low percentage of the Leavenworth National Fish Hatchery population historically detected straying.

The Wenatchee spring Chinook population is currently distributed across four interconnected spawning watersheds (Chiwawa, Nason, White, and Little Wenatchee), which increases

[38] It should be noted that efforts to recover tags on spawning grounds varied prior to 1993.

population diversity. However, compared to the historical condition, the current distribution of naturally produced spring Chinook in the Wenatchee subbasin is reduced because of the loss of naturally produced fish spawning in tributaries downstream from Tumwater Canyon.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005a and shown in Appendix B) that determine diversity and spatial structure, the Wenatchee spring Chinook population is currently considered to be at a high risk of extinction (**Table 2.2**). Two metrics that kept the population from achieving a low risk rating were: (1) Chiwawa hatchery fish (local origin stock) have averaged more than 30% of total spawners and more than 10% of the spawner composition in other non-target major spawning areas and (2) there is a high proportion (3-27%) of out-of-basin hatchery produced fish from the Leavenworth National Fish Hatchery on spawning grounds (Appendix B). Based only on abundance and productivity, the Wenatchee spring Chinook population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.4**). Combining all VSP parameters together (using method described in ICBTRT 2005a), the Wenatchee spring Chinook population is not currently viable and has a high risk of extinction (**Table 2.3**).[39]

Entiat

Abundance

From 1960 to 2003, abundance of age 3+ spring Chinook in the Entiat subbasin ranged from 18 to 1,197 fish (**Table 2.1**; **Figure 2.5**).[40] During this period the 12-year geometric mean of spawners in the subbasin ranged from 90 to 490 adults (**Table 2.1**; **Figure 2.5**). The geometric mean at the time of listing (1999) was 92 spawners.

Productivity

During the period 1960 to 1999, returns per spawner for spring Chinook in the Entiat subbasin ranged from 0.16 to 4.72 (**Table 2.1**; **Figure 2.5**). The 12-year geometric mean of returns per spawner during this period ranged from 0.41 to 1.12 (**Table 2.1**; **Figure 2.5**). The geometric mean at the time of listing (1999) was 0.76. Presently there are too few data to estimate tributary productivity (smolts/redd) for Entiat spring Chinook. When more data are available, this plan will estimate tributary productivity of Entiat spring Chinook.

Spatial structure and diversity

Hamstreet and Carie (2003) described the current spawning distribution for spring Chinook in the Entiat subbasin as the Entiat River (river mile 16.2 to 28.9) and the Mad River (river mile 1.5-5.0) (**Figure 2.6**). The original diversity of the Entiat population was reduced because of hatchery practices, past harvest, hydropower development including dams that blocked passage

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[39] Risk of extinction based on the four VSP parameters was based on guidance from the ICBTRT (2005a).

[40] Out-of-basin, hatchery produced spring Chinook return to the Entiat subbasin. Some of these fish contribute to the spawning population. There is presently no way to remove these spawners from the estimated returns. The degree of introgression of out-of-basin stock with naturally produced fish remains questionable.

into the Entiat River, habitat degradation, and releases of out-of-basin stock[41] from the Entiat National Fish Hatchery.[42] The Entiat River has a history of impoundments from the late 1880s through the first half of the 1900s. The U.S. Bureau of Fisheries surveys in the 1930s noted that three dams without fish passage remained on the Entiat River (Bryant and Parkhurst 1950). Because of its small size (relative to other subbasins in the Upper Columbia) and natural barriers, the Entiat subbasin offers limited numbers of suitable habitat areas for spring Chinook. Therefore, this population would naturally be at a higher risk than other populations in the Upper Columbia because of the naturally limited size of spawning and rearing habitat.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Entiat spring Chinook population is currently considered to be at a high risk of extinction (**Table 2.2**). Two factors contributed to this high-risk rating and both were related to the Entiat National Fish Hatchery propagating out-of-basin spring Chinook (Appendix B). Based only on abundance and productivity, the Entiat spring Chinook population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.7**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Entiat spring Chinook population is not currently viable and has a high risk of extinction (**Table 2.3**).

Methow

Abundance

From 1960 to 2003, abundance of age 3+ spring Chinook in the Methow subbasin ranged from 33 to 9,904 adults (**Table 2.1**; **Figure 2.8**).[43] During this period the 12-year geometric mean of spawners in the subbasin ranged from 480 to 2,231 adults (**Table 2.1**; **Figure 2.8**). The geometric mean at the time of listing (1999) was 480 spawners.

Productivity

During the period 1960 to 1999[44], returns per spawner for spring Chinook in the Methow subbasin ranged from 0.05 to 5.21 (**Table 2.1**; **Figure 2.8**). The 12-year geometric mean of returns per spawner during this period ranged from 0.41 to 1.02 (**Table 2.1**; **Figure 2.8**). The geometric mean at the time of listing (1999) was 0.51. Presently there are too few data to

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[41] The fish at the Entiat National Fish Hatchery at the time of listing originated from "Carson stock," which were derived from the collection of co-mingled spring Chinook trapped annually between 1955 and 1964 at Bonneville Dam. Recent genetic information indicates that these fish are a mix of Upper Columbia and Snake River populations (Pastor 2004).

[42] Tagging studies indicate that about 6% of the spring Chinook produced at the Entiat National Fish Hatchery stray into other areas (Pastor 2004). During low natural return years, strays of out-of-basin fish can make up a substantial proportion of naturally spawning fish (Hamstreet and Carie 2003).

[43] Estimates of spawners, returns, and their geometric means of Methow spring Chinook do not include fish returning in 1996 or 1998 because all returns in these years were captured at Wells Dam and used in the hatchery program. Carson origin fish have undoubtedly been added into the number of returns, since not all hatchery fish have been marked (until recent releases). It is not possible to separate Carson fish from the returning population.

[44] The series only goes to 1999 because not all fish produced from parents that spawned after 1999 have returned from the ocean.

estimate tributary productivity (smolts/redd) for Methow spring Chinook. When more data are available, this plan will estimate tributary productivity of Methow spring Chinook.

Spatial structure and diversity

Spring Chinook currently spawn in the mainstem Methow River and the Twisp, Chewuch, and Lost drainages (Scribner et al. 1993; Humling and Snow 2004). A few also spawn in Gold, Wolf, and Early Winters creeks (**Figure 2.9**). The original diversity of the Methow population was reduced because of man-made barriers near the confluence, early 1900s hatchery practices, the GCFMP, past harvest, hydropower development, habitat degradation, and the release of out-of-basin stock from the Winthrop National Fish Hatchery.[45] The USFWS transitioned from the release of out-of-basin stock to the listed stock from 2000 to 2006 (B. Cates, personal communication, USFWS). The population is currently distributed across three major watersheds (Twisp, Chewuch, and Upper Methow), which increases population diversity and reduces risk from catastrophic events.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Methow spring Chinook population is currently considered to be at a high risk of extinction (**Table 2.2**; Appendix B). Two factors contributed to this high-risk rating: (1) there is very little divergence occurring within the population; and (2) out-of-basin Carson stock were propagated in the past and the genetic legacy of these out-of-basin fish is still significant in fish used in the state and federal hatchery programs (Appendix B). Based only on abundance and productivity, the Methow spring Chinook population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.4**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Methow spring Chinook population is not currently viable and has a high risk of extinction (**Table 2.3**).

Okanogan

Abundance

Currently, there are no naturally produced Spring Chinook in the Okanogan subbasin. A recent run of the Ecosystem Diagnosis and Treatment (EDT) model predicted that a viable population of spring Chinook cannot be maintained currently because of in-basin and out-of-basin factors (see Section 3.7 and Okanogan Subbasin Plan 2005).

Productivity

There is presently no production of spring Chinook in the Okanogan subbasin.

Spatial structure and diversity

Spring Chinook do not naturally occur within the Okanogan subbasin. In 2002, the USFWS released out-of-basin, Carson-stock spring Chinook smolts and fry into Omak Creek. As noted

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[45] As noted earlier, the fish at the Winthrop National Fish Hatchery at the time of listing originated from “Carson stock,” which were derived from the collection of about 500 co-mingled spring Chinook trapped annually between 1955 and 1964 at Bonneville Dam. Recent genetic information indicates that these fish are a mix of Upper Columbia and Snake River populations (Pastor 2004).

earlier, these fish are not part of the ESU. Salmon Creek probably has the greatest habitat potential in the U.S. portion of the Okanogan subbasin (Okanogan Subbasin Plan 2005).

Upper Columbia Steelhead

Current (from 1960s to present) abundance and productivity for each population of steelhead in the Upper Columbia Basin were based on annual dam counts and returns per spawner (spawner to spawner return rates), respectively. Abundance was based on annual dam counts, not redd counts, because redd counts were not routinely conducted for steelhead until recently (2001). The total return from each spawning year was reconstructed by breaking each year's return down into components by age and summing those components by brood year (across return years). Annual return estimates were partitioned by age using age estimates obtained from the Wells and Priest Rapids sampling programs. Only anadromous steelhead were included in estimation of VSP parameters.[46] See Appendix C for a detailed description of the steelhead run reconstruction.

Wenatchee

Abundance

Between 1967 and 2003, escapement of naturally produced steelhead in the Wenatchee subbasin ranged from 70 to 2,864 (**Table 2.4**; **Figure 2.10**). During this same time period, the 12-year geometric mean ranged from 185 to 919 adults. The geometric mean at the time of listing (1997) was 793 (**Table 2.4**; **Figure 2.10**).

Productivity

The return per spawner of Wenatchee steelhead (and the Entiat, Methow, and Okanogan populations) depends on how effective hatchery-produced spawners have been in producing future spawners (recruits). Two scenarios are described that are based on the assumptions that (1) hatchery fish are equally as effective in producing returning spawners as naturally produced steelhead, and (2) that hatchery fish contribute no returning spawners (see Appendix C for details). Also, as noted in Appendix C, as spawning ground surveys and subsequent information (e.g., hatchery-naturally produced composition, hatchery spawner egg voidance, etc.) increase, it will be important to reevaluate the information and methodologies presented here.

Assuming that hatchery fish are as effective as naturally produced steelhead, the return per spawner ranged from 0.05 to 0.79 (**Table 2.4**). The 12-year geometric mean for this scenario ranged from 0.18 to 0.32. The geometric mean at the time of listing (1997) was 0.25.

If hatchery fish do not contribute to returning adults, then the return per spawner ranged from 0.13 to 4.73 (**Table 2.4**). The 12-year geometric mean for this scenario ranged from 0.71 to 1.96. The geometric mean at the time of listing (1997) was 0.81. The "true" productivity of Wenatchee steelhead lies somewhere between this scenario and the scenario that hatchery produced steelhead are as effective as naturally produced steelhead.

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[46] Resident rainbow trout are not included in VSP estimates for reason given in Section 2.1.

Spatial structure and diversity

Steelhead currently spawn and rear in the Wenatchee River between 37 Tumwater Canyon and Nason Creek, the Chiwawa River, and in Nason, Icicle, Peshastin, Chumstick, and Mission creeks (**Figure 2.13**). Steelhead may also spawn and rear in the Little Wenatchee and White rivers and Chiwaukum Creek. The diversity of the Wenatchee population was reduced because of past harvest and hatchery practices, hydropower development, and habitat degradation. The Wenatchee steelhead population is currently distributed across several interconnected spawning watersheds (Chiwawa, Nason, Icicle, Peshastin, Chumstick, and Mission), which increases population diversity.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Wenatchee steelhead population is currently considered to be at a high risk of extinction (**Table 2.2**). The high rating was based primarily on the proportion of natural spawners that consist of hatchery-produced fish (Appendix B). The high proportion results from collecting broodstock at Dryden Dam, rather than within specific spawning tributaries. Based only on abundance and productivity, the Wenatchee steelhead population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.14**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Wenatchee steelhead population is not currently viable and has a moderate to high risk of extinction (**Table 2.5**).

Entiat

Abundance

Between 1967 and 2003, escapement of naturally produced steelhead in the Entiat subbasin ranged from 9 to 366 (**Table 2.4**; **Figure 2.15**). During this same time period, the 12-year geometric mean ranged from 24 to 118 adults. The geometric mean at the time of listing (1997) was 101 (**Table 2.4**; **Figure 2.15**).

Productivity

Assuming that hatchery fish are as effective as naturally produced steelhead, the return per spawner ranged from 0.05 to 0.79 (**Table 2.4**). The 12-year geometric mean for this scenario ranged from 0.18 to 0.32. The geometric mean at the time of listing (1997) was 0.25.

If hatchery fish do not contribute to returning adults, then the return per spawner ranged from 0.13 to 4.73 (**Table 2.4**). The 12-year geometric mean for this scenario ranged from 0.71 to 1.96. The geometric mean at the time of listing (1997) was 0.81. The “true” productivity of Entiat steelhead lies somewhere between this scenario and the scenario that hatchery produced steelhead are as effective as naturally produced steelhead.

Spatial structure and diversity

Steelhead currently spawn and rear in the mainstem Entiat River and from RM 0.5 discontinuously upstream to RM 28. Spawning and rearing in the Mad River occurs from RM 1.3 to RM 7.2 (**Figure 2.16**). Tributary use has been documented in lower Tillicum, Roaring, Stormy creeks. The upstream extent of steelhead in Roaring Creek is unknown.

The original diversity of the Entiat population was reduced because of the past harvest, hydropower development including dams that blocked passage into the Entiat River, habitat degradation, hatchery practices, and the GCFMP. Because of its small size (relative to other subbasins in the Upper Columbia) and natural barriers, the Entiat subbasin offers limited numbers of suitable habitat patches for steelhead. We note that the Entiat population was probably always at an intermediate to high risk because of its small size, low capacity to produce steelhead, and simple spatial structure.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Entiat steelhead population is currently considered to be at a high risk of extinction (**Table 2.2**). The high rating was based primarily on the proportion of out-of-basin hatchery spawners (Appendix B). These spawners consist of strays from the Wells and Wenatchee hatchery programs. Based only on abundance and productivity, the Entiat steelhead population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.17**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Entiat steelhead population is not currently viable and has a moderate to high risk of extinction (**Table 2.5**).

Methow

Abundance

Between 1967 and 2002, escapement of naturally produced steelhead in the Methow subbasin ranged from 1 to 587 (**Table 2.6**; **Figure 2.18**). During this same time period, the 12-year geometric mean ranged from 36 to 242 adults. The geometric mean the year before listing (1996) was 205 (**Table 2.6**; **Figure 2.18**).

Productivity

Assuming that hatchery fish are as effective as naturally produced steelhead, the return per spawner ranged from 0.01 to 1.20 (**Table 2.6**; **Figure 2.19**). The 12-year geometric mean for this scenario ranged from 0.07 to 0.16. The geometric mean the year before listing (1996) was 0.09.

If hatchery fish do not contribute to returning adults, then the return per spawner ranged from 0.08 to 8.65 (**Table 2.6**; **Figure 2.19**). The 12-year geometric mean for this scenario ranged from 0.82 to 2.28. The geometric mean the year before listing (1996) was 0.84. The “true” productivity of Methow steelhead lies somewhere between this scenario and the scenario that hatchery produced steelhead are as effective as naturally produced steelhead.

Spatial structure and diversity

In the Methow subbasin, steelhead currently spawn and rear in the Twisp, mainstem Methow, and Chewuch rivers, and in Beaver and Winthrop National Fish Hatchery creeks (Jateff and Snow 2002). A few steelhead (based on less than 15 redds) also spawn in the Lost River and Buttermilk, Boulder, Methow Hatchery, Eight-Mile, Little Bridge, Libby, Black Canyon, War, Poorman, Eagle, and Lake creeks (**Figure 2.20**). No steelhead have been observed in Wolf creek. The original diversity of the Methow population was reduced because of the GCFMP, past harvest, hydropower development, and habitat degradation. The population is currently distributed across three major watersheds (Twisp, Chewuch, and Upper Methow), which increases population diversity and reduces risk from catastrophic events.

When considering the 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Methow steelhead population is currently considered to be at a high risk of extinction (**Table 2.2**). The proportion of natural spawners that were hatchery fish contributed most to this designation (Appendix B). Based only on abundance and productivity, the Methow steelhead population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.13**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Methow steelhead population is not currently viable and has a moderate to high risk of extinction (**Table 2.5**).

Okanogan

Abundance

Between 1967 and 2002, escapement of naturally produced steelhead in the Okanogan subbasin ranged from 1 to 156 (**Table 2.6**; **Figure 2.21**). During this same time period, the 12-year geometric mean ranged from 11 to 64 adults. The geometric mean the year before listing (1996) was 53 (**Table 2.6**; **Figure 2.21**). In 2005, 300 redds were counted in the U.S. portion of the Okanogan subbasin (Colville Tribes, personal communication).

Productivity

Assuming that hatchery fish are as effective as naturally produced steelhead, the return per spawner ranged from 0.01 to 1.20 (**Table 2.6**; **Figure 2.19**). The 12-year geometric mean for this scenario ranged from 0.07 to 0.16. The geometric mean the year before listing (1996) was 0.09.

If hatchery fish do not contribute to returning adults, then the return per spawner ranged from 0.08 to 8.65 (**Table 2.6**; **Figure 2.19**). The 12-year geometric mean for this scenario ranged from 0.82 to 2.28. The geometric mean the year before listing (1996) was 0.84. The “true” productivity of Okanogan steelhead lies somewhere between this scenario and the scenario that hatchery produced steelhead are as effective as naturally produced steelhead.

Spatial structure and diversity

Steelhead currently spawn in Omak Creek, Similkameen River, mainstem Okanogan River, and occasionally spawn in other tributaries to the Okanogan river. Additionally, there are four steelhead production areas within the Canadian portion of the Okanogan subbasin (**Figure 2.22**). The original diversity of the Okanogan population was reduced because of the GCFMP, past harvest, hydropower development, hatchery practices, and habitat degradation. The population is currently distributed only across two watersheds (Omak and Similkameen), which decreases population diversity and increases risk from catastrophic events.

When considering 9 factors (and 12 metrics identified in ICBTRT 2005 and shown in Appendix B) that determine diversity and spatial structure, the Okanogan steelhead population is currently considered to be at a high risk of extinction (**Table 2.2**). Based on abundance and productivity, the Okanogan steelhead population is not viable and has a greater than 25% chance of extinction in 100 years (**Figure 2.16**). Combining all VSP parameters together (using method described in ICBTRT 2005), the Okanogan steelhead population is not currently viable and has a high risk of extinction (**Table 2.5**).

Upper Columbia Bull Trout

Because of a lack of detailed information on the population dynamics of bull trout in the Upper Columbia Basin, a different approach was used to estimate VSP parameters for bull trout. Bull trout abundance was estimated as the number of redds times 2.0 to 2.8 fish per redd. This approach provided a range of abundance estimates for bull trout within each core area (USFWS 2004, 2005). Productivity was based on trends in redd counts, while diversity was based on general life-history characteristics of bull trout (resident, fluvial, and adfluvial) within each core area. Although these parameters are less rigorous than the parameters used to estimate status of spring Chinook and steelhead, they provide relative indices of abundance, productivity, and diversity.

Wenatchee

Abundance

The USFWS, USFS, and WDFW have conducted bull trout spawning surveys in various streams within the Wenatchee subbasin since the early 1980s. Bull trout redd surveys in the Wenatchee subbasin have changed over time and different streams have different survey periods (e.g., White/Little Wenatchee from 1983 to present, Chiwawa from 1989 to present, Nason from 1996 to present, etc.). Numbers of redds have ranged from 2 to 123 in the White/Little Wenatchee drainages, 1-15 in Nason Creek, and 93-462 in the Chiwawa drainage (**Table 2.7**). Surveys from 2000-2004 were conducted consistently across all populations and redds counts during this period ranged from 309 to 607 in the core area.

Productivity

Directly comparable data from redd surveys for all the local populations only occurs from 2000 to present. For streams with long-term redd counts, numbers of redds have increased over time (e.g., Chiwawa basin). However, there is a fair amount of variability in all the other populations (**Table 2.7**). Number of redds for Little Wenatchee, Nason Creek, Ingalls Creek, and Chiwaukum Creek are very low, and the location of spawning grounds in Icicle Creek is unknown. However, multiple size classes of bull trout have been observed in upper Icicle Creek during USFWS surveys in 1994, 1995, and 2004.

Spatial structure and diversity

Bull trout currently occur in the Chiwawa River, White River, Little Wenatchee River, Nason Creek, Chiwaukum Creek, Icicle Creek, Peshastin Creek, Negro Creek, and Ingalls Creek drainages (USFWS 2002) (**Figure 2.22**). Adfluvial, fluvial, and resident forms of bull trout exist in the Wenatchee subbasin (USFWS 2002).

Entiat

Abundance

The U.S. Forest Service (USFS) has conducted bull trout redd surveys in the Entiat subbasin since 1989, primarily in the Mad River (**Table 2.7**). Numbers have ranged from 10 to 52 redds in the Mad River and 0 to 46 redds in the Entiat River. The large increase in numbers of redds counted in the Entiat River in 2004 resulted from increasing the survey area and changes in survey effort.

Productivity

Numbers of bull trout redds in the Entiat subbasin have increased since they were first counted in 1989, suggesting an increasing trend in production (**Table 2.7**).

Spatial structure and diversity

Bull trout occur in both the Mad and Entiat rivers (USFWS 2002) (**Figure 2.22**). Natural falls currently restrict the distribution of migratory bull trout in the Entiat subbasin. However, there have been minimal bull trout surveys conducted upstream from the falls. It is assumed that most of the bull trout in the Entiat subbasin are fluvial fish, with perhaps a resident form in the upper reaches of the Mad River drainage. Bull trout have been observed in Tillicum and Stormy creeks (USFWS 2002). Recent studies suggest that bull trout from this core area use the mainstem Columbia River for overwintering habitat and foraging (BioAnalysts Inc. 2002, 2003).

Methow

Abundance

Redd surveys in the Methow subbasin began in the early 1990s and were conducted by the USFS, USFWS, WDFW, and others. Total numbers of redds within the subbasin have ranged from 4 to 195 redds (**Table 2.7**). However, these are not valid estimates of abundance, because not all bull trout spawning streams were surveyed annually, lengths of surveys reaches have changed within a given stream, and survey methods have changed over time. Based on more recent surveys (2000-2004), when survey methods were more similar, redd counts ranged from 127 to 195. There is a bull trout fishery in the Lost River. It is uncertain as to what effect this has on the Methow core population. Another factor that may have affected bull trout abundance is the closure of the steelhead fishery between 1997 and 2001.

Productivity

Numbers of redds counted in the Methow subbasin appear to have increased since the mid-1990s. However, this trend is an artifact of changing survey methods. Looking at recent years (2000-2004), when survey methods were similar, there was a fairly stable number of redds ranging from 147 in 2000 to 148 in 2004. Currently, there is insufficient data to establish a trend for the entire core area. In the Twisp and the Upper Methow areas, redd counts are highly variable, but reveal a decreasing trend since 2000 (**Table 2.7**).

Spatial structure and diversity

The distribution of bull trout in the Methow subbasin is somewhat less than it was historically. Currently bull trout occur within the Twisp River, Chewuch River, Lake Creek, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, Beaver Creek, Foggy Dew Creek, Crater Cree, Eightmile Creek, Buttermilk Creek, Little Bridge Creek, North Creek, and Goat Creek drainages (USFWS 2002) (**Figure 2.22**). Bull trout exist upstream of the anadromous fish barrier on Early Winters Creek. The population structure of the Lost River is unknown, but likely contributes to the genetic diversity of the Methow core population. The presence of bull trout in the Gold Creek drainage is unknown. No redds have been observed there in recent years. The USFWS believes that bull trout in Beaver Creek were reduced because of competition and introgression with brook trout, irrigation diversions, and fish passage problems (J. Craig, USFWS, personal communication). Resident, fluvial, and adfluvial forms still occur in the Methow subbasin (USFWS 2002).

Table 2.1 Adult (age >3) spawner-to-spawner return estimates and 12-year geometric means (GM) of spawners (S) and returns per spawner (R/S) for Upper Columbia spring Chinook. Return levels for brood years 1960-1969 were adjusted to reflect historical average harvest. Spawner numbers include both hatchery and naturally produced fish. Data are from T. Cooney (NOAA Fisheries).

Brood Year	Wenatchee					Entiat					Methow				
	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S
60	2371	3290	1.39			365	998	2.73			2313	3587	1.55		
61	1540	4290	2.79			137	528	3.86			665	2751	4.14		
62	3056	5645	1.85			359	863	2.41			2813	3863	1.37		
63	1874	4524	2.41			452	786	1.74			2093	2624	1.25		
64	2771	4514	1.63			1197	727	0.61			4198	2010	0.48		
65	3523	3588	1.02			324	424	1.31			1556	1655	1.06		
66	6718	2082	0.31			957	260	0.27			4927	1499	0.30		
67	3978	2390	0.60			786	329	0.42			2621	1683	0.64		
68	4663	4106	0.88			786	406	0.52			1958	2082	1.06		
69	3959	3797	0.96			415	525	1.26			1405	1825	1.30		
70	3026	3308	1.09			218	407	1.87			1824	1760	0.97		
71	1589	2722	1.71	2977	1.19	424	342	0.81	451	1.12	1535	1371	0.89	2061	1.02
72	2783	2326	0.84	3017	1.14	190	246	1.30	427	1.05	1644	1099	0.67	2003	0.95
73	5863	3818	0.65	3372	1.01	714	732	1.03	490	0.94	2415	2443	1.01	2231	0.85
74	1989	2652	1.33	3254	0.99	274	788	2.87	480	0.96	1193	1828	1.53	2077	0.86
75	3765	1207	0.32	3449	0.83	486	257	0.53	482	0.87	2108	449	0.21	2078	0.74
76	2401	1491	0.62	3408	0.77	147	299	2.03	405	0.96	713	389	0.55	1793	0.75
77	2862	2342	0.82	3349	0.76	533	321	0.60	422	0.90	1986	445	0.22	1830	0.66

Brood Year	Wenatchee					Entiat					Methow				
	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S
78	3772	2593	0.69	3192	0.81	1016	315	0.31	424	0.91	2601	507	0.20	1735	0.63
79	1063	1406	1.32	2859	0.86	253	277	1.09	386	0.98	524	480	0.92	1517	0.65
80	1519	3025	1.99	2604	0.92	334	208	0.62	360	1.00	438	1064	2.43	1339	0.70
81	1595	4045	2.54	2414	1.00	296	344	1.16	350	0.99	467	735	1.57	1222	0.71
82	1819	2873	1.58	2314	1.03	334	249	0.75	362	0.92	558	1355	2.43	1107	0.76
83	3286	1693	0.52	2459	0.93	334	226	0.68	355	0.91	861	1190	1.38	1055	0.79
84	2341	1105	0.47	2423	0.89	265	55	0.21	365	0.78	929	1167	1.26	1006	0.84
85	4529	1380	0.30	2372	0.84	359	184	0.51	345	0.73	1232	1081	0.88	951	0.83
86	2674	886	0.33	2431	0.74	327	146	0.45	350	0.63	909	733	0.81	930	0.78
87	1878	1065	0.57	2294	0.78	200	86	0.43	325	0.62	1496	726	0.49	903	0.84
88	1692	696	0.41	2228	0.75	209	232	1.11	335	0.59	1641	1963	1.20	968	0.90
89	1349	829	0.61	2093	0.74	115	153	1.33	294	0.63	1144	668	0.58	925	0.97
90	927	183	0.20	1862	0.66	259	41	0.16	263	0.59	1104	59	0.05	861	0.87
91	552	122	0.22	1763	0.57	100	22	0.22	243	0.52	550	78	0.14	865	0.74
92	1080	70	0.06	1713	0.43	131	44	0.34	225	0.49	1630	173	0.11	965	0.57
93	1179	124	0.11	1671	0.33	312	58	0.19	226	0.42	1357	206	0.15	1054	0.47
94	275	205	0.75	1427	0.31	75	38	0.51	199	0.41	293	145	0.49	999	0.41
95	51	229	4.53	1008	0.37	18	34	1.91	156	0.45	33	172	5.21	761	0.46
96	158	506	3.20	805	0.44	44	132	2.99	135	0.56	*	822			
97	385	1768	4.59	656	0.55	81	291	3.59	119	0.66	339	1289	3.80	665	0.48

Brood Year	Wenatchee					Entiat					Methow				
	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S	Spawner	Returns	R/S	GM S	GM R/S
98	183	686	3.76	524	0.67	53	250	4.72	102	0.80	*	588			
99	119	248	2.09	417	0.74	59	14	0.25	92	0.76	79	112	1.41	480	0.51
00	620			383		152			90		805			447	
01	4446			423		444			101		9904			555	
02	1651			444		246			100		2622			605	
03	539			443		238			108		1047			645	

* Nearly all spring Chinook spawners returning to the Methow in 1996 and 1998 were collected for hatchery broodstock. There were no spawning surveys conducted in those years to determine if some fish escaped and spawned in the Methow subbasin.

Table 2.2 Goals, associated mechanisms, factors, and levels of risk (L-low; M-medium; H-high) for diversity and spatial structure of Upper Columbia spring Chinook and steelhead. Table was developed following guidance from ICBTRT (2005a) (see Appendix B). Wen = Wenatchee, Ent = Entiat, Met = Methow, and Okan = Okanogan.

Goal	Mechanism	Factor	Spring Chinook			Steelhead			
			Wen	Ent	Met	Wen	Ent	Met	Okan
Allowing natural rates and levels of spatially mediated processes	Maintain natural distribution of spawning aggregates	Number and spatial arrangement of spawning areas	L	M	L	L	M	L	H
		Spatial extent or range of population							
		Increase or decrease gaps or continuities between spawning aggregates							
Maintaining natural levels of variation	Maintain natural patterns of phenotypic and genotypic expression	Major life-history strategies	H	H	H	H	H	H	H
		Phenotypic variation							
		Genetic variation							
	Maintain natural patterns of gene flow	Spawner composition							
	Maintain occupancy in a natural variety of available habitat types	Distribution of population across habitat types							
	Maintain integrity of natural systems	Selective in natural processes or impacts							

Table 2.3 Viability ranking of current populations of Upper Columbia River spring Chinook (spatial structure/diversity based on **Table 2.3**; Abundance/Productivity based on **Figure 2.4** and **Figure 2.7**) (table developed based on guidance from ICBTRT 2005a) (see Appendix B)

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/Productivity Risk	**Very Low (<1%)**				
	Low (1-5%)				
	Moderate (6-25%)				
	High (>25%)				Wenatchee Entiat Methow

Table 2.4 Summary statistics for naturally produced (NP) steelhead escapement and run reconstruction for Wenatchee and Entiat populations. GM = 12-year geometric mean; HE = hatchery effectiveness. See Appendix C for a detailed description of run reconstructions.

Year	NP steelhead escapement		GM NP steelhead escapement		Returns		Returns per spawner		GM Returns per spawner	
	Wenatchee	Entiat	Wenatchee	Entiat	Wenatchee	Entiat	HE = 0	HE = 1	GM HE = 0	GM HE = 1
1967	1316	168			257	33	0.20	0.14		
1968	1878	240			244	31	0.13	0.08		
1969	858	110			173	22	0.20	0.09		
1970	138	18			137	18	0.99	0.31		
1971	377	48			110	14	0.29	0.05		
1972	150	19			191	24	1.27	0.17		
1973	219	28			300	38	1.37	0.18		
1974	82	10			284	36	3.46	0.47		
1975	97	12			229	29	2.37	0.32		
1976	184	24			249	32	1.35	0.28		
1977	450	58			249	32	0.55	0.11		
1978	146	19	290	37	276	35	1.88	0.33	0.75	0.18
1979	305	39	256	33	459	59	1.51	0.28	0.88	0.19
1980	176	22	210	27	774	99	4.40	0.79	1.19	0.22
1981	355	45	196	25	1034	132	2.91	0.58	1.48	0.26
1982	70	9	185	24	1368	175			1.54	0.26
1983	679	87	194	25	1318	168	1.94	0.24	1.83	0.30
1984	683	87	220	28	1883	241	2.76	0.43	1.96	0.32
1985	1382	177	257	33	1406	180	1.02	0.19	1.91	0.32

Year	NP steelhead escapement		GM NP steelhead escapement		Returns		Returns per spawner		GM Returns per spawner	
	Wenatchee	Entiat	Wenatchee	Entiat	Wenatchee	Entiat	HE = 0	HE = 1	GM HE = 0	GM HE = 1
1986	1315	168	323	41	1011	129	0.77	0.20	1.66	0.30
1987	1993	255	416	53	723	92	0.36	0.16	1.40	0.28
1988	1062	136	482	62	1125	144	1.06	0.36	1.37	0.29
1989	1676	214	538	69	536	69	0.32	0.18	1.31	0.30
1990	594	76	604	77	524	67	0.88	0.26	1.22	0.29
1991	1036	133	669	86	432	55	0.42	0.26	1.08	0.29
1992	830	106	761	97	485	62	0.58	0.15	0.90	0.25
1993	507	65	784	100	437	56	0.86	0.28	0.81	0.23
1994	471	60	919	118	301	39	0.64	0.13	0.79	0.22
1995	673	86	919	117	369	47	0.55	0.18	0.71	0.22
1996	393	50	877	112	1111	142	2.82	0.56	0.71	0.22
1997	410	52	793	101	1941	248	4.73	0.74	0.81	0.25
1998	273	35	696	89						
1999	443	57	614	78						
2000	1196	153	620	79						
2001	2864	366	648	83						
2002	1291	165	691	88						
2003	1588	203	716	92						

Table 2.5 Viability ranking of current populations of Upper Columbia River steelhead (spatial structure/diversity based on **Table 2.3**; Abundance/Productivity based on **Figure 2.14** and **Figure 2.17**) (Table developed based on guidance from ICBTRT 2005a; see Appendix B)

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/Productivity Risk	**Very Low (<1%)**				
	Low (1-5%)				
	Moderate (6-25%)				
	High (>25%)				Okanogan Wenatchee Entiat Methow

Table 2.6 Summary statistics for naturally produced (NP) steelhead escapement and run reconstruction for Methow and Okanogan populations. GM = 12-year geometric mean; HE = hatchery effectiveness. See Appendix C for a detailed description of run reconstructions

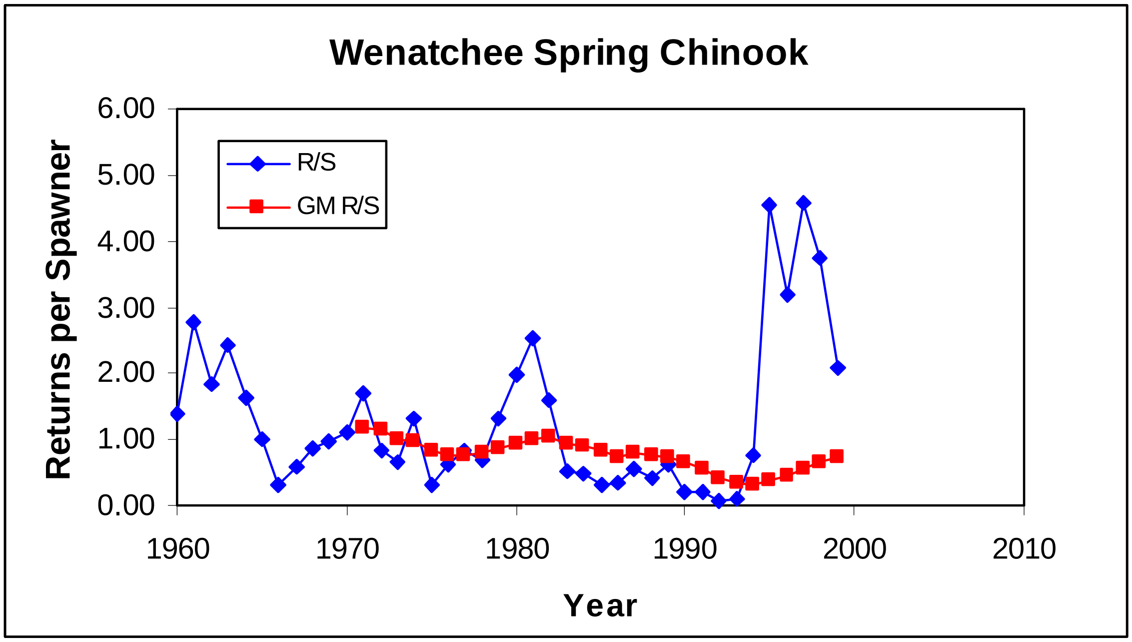
Year	NP steelhead escapement		GM NP steelhead escapement		Returns		Returns per spawner		GM Returns per spawner	
	Methow	Okanogan	Methow	Okanogan	Methow	Okanogan	HE = 0	HE = 1	GM HE = 0	GM HE = 1
1967	135	36			161	43	1.19	0.75		
1968	565	150			124	33	0.22	0.14		
1969	268	71			30	8	0.11	0.05		
1970	69	18			17	5	0.24	0.08		
1971	278	74			21	6	0.08	0.01		
1972	35	9			68	18	1.92	0.17		
1973	27	7			112	30	4.12	0.19		
1974	11	3			84	22	7.49	0.34		
1975	1	1			57	15				
1976	95	25			66	17	0.70	0.06		
1977	161	43			99	26	0.62	0.06		
1978	17	5	57	17	151	40	8.65	0.78	0.82	0.13
1979	101	27	55	16	128	34	1.26	0.11	0.83	0.11
1980	9	2	39	12	124	33		1.20	0.95	0.13
1981	143	38	37	11	185	49	1.29	0.12	1.21	0.14
1982	186	49	41	12	264	70	1.42	0.08	1.44	0.14
1983	77	21	36	11	290	77	3.75	0.04	2.13	0.16
1984	125	33	41	12	474	126	3.78	0.09	2.28	0.15
1985	239	64	49	14	392	104	1.64	0.06	2.08	0.14
1986	262	70	63	19	364	97	1.39	0.08	1.75	0.12

Year	NP steelhead escapement		GM NP steelhead escapement		Returns		Returns per spawner		GM Returns per spawner	
	Methow	Okanogan	Methow	Okanogan	Methow	Okanogan	HE = 0	HE = 1	GM HE = 0	GM HE = 1
1987	453	120	105	28	340	90	0.75	0.13	1.62	0.12
1988	316	84	116	31	455	121	1.44	0.24	1.73	0.13
1989	401	106	126	33	147	39	0.37	0.08	1.65	0.14
1990	315	83	160	42	99	26	0.31	0.06	1.22	0.11
1991	552	146	184	49	68	18	0.12	0.02	0.99	0.10
1992	252	67	242	64	91	24	0.36	0.04	0.91	0.07
1993	130	34	240	64	130	35	1.01	0.10	0.89	0.07
1994	90	24	226	60	116	31	1.29	0.07	0.89	0.07
1995	77	20	226	60	213	56	2.76	0.31	0.86	0.08
1996	140	37	228	60	374	99	2.67	0.14	0.84	0.09
1997	66	17	205	54						
1998	151	40	195	52						
1999	326	86	190	50						
2000	316	84	190	50						
2001	587	156	196	52						
2002	434	115	202	53						

Table 2.7 Bull trout redd counts from streams in the Upper Columbia Basin for years 1983-2003 (data from USFWS and USFS)

Stream /drainage	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Wenatchee Core Area																						
White/Little Wenatchee	45	20	4	2	11	32	33	7	37	26	45	48	26	29	18	35	44	65	22	123	64	54
Chiwaukum watershed																			29	35	42	23
Nason watershed														3	1	9	15	13	3	7	3	15
Chiwawa watershed							176	93	332	255	230	207	405	358	324	347	462	400	254	437	421	376
Peshastin watershed																		0	1	5	9	
Total:	**45**	**20**	**4**	**2**	**11**	**32**	**209**	**100**	**369**	**281**	**275**	**255**	**431**	**390**	**343**	**391**	**521**	**478**	**309**	**607**	**539**	**468**
Entiat Core Area																						
Mad River							18	17	21	16	10	17	16	23	23	43	30	45	34	26	52	37
Entiat River												3	3	2	0	1	6	1	4	7	5	46
Total:							**18**	**17**	**21**	**16**	**10**	**20**	**19**	**25**	**23**	**44**	**36**	**46**	**38**	**33**	**57**	**83**
Methow Core Area																						
Upper Methow watershed										7			33	26	15	13	1	5	27	60		22
Chewuch watershed													22	13	9	8	0	18	31	22	20	10
Twisp watershed										4	5	4	25	0	2	86	101	105	76	93	86	101

Stream /drainage	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Middle Methow watershed													0	3	3	27	29	26	20	19	21	36
Lower Methow watershed														2	2	1	0		0	1	0	
Total:										**11**	**5**	**4**	**80**	**44**	**31**	**135**	**131**	**165**	**154**	**195**	**127**	**169**



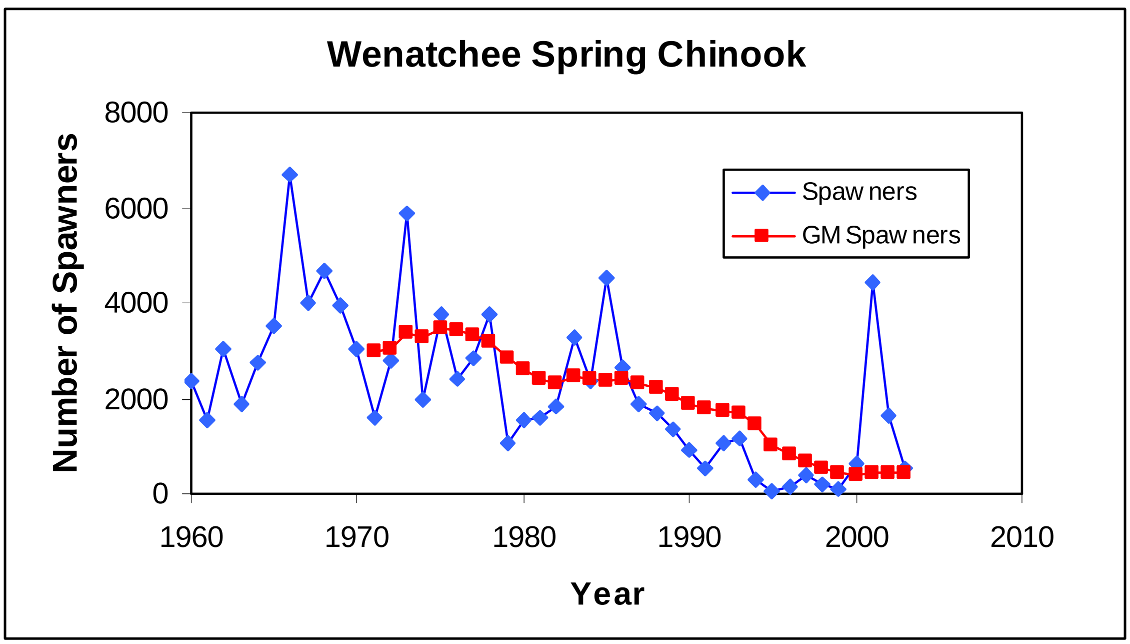


Figure 2.1 Spring Chinook spawners and returns per spawner (R/S) and their 12-year geometric means (GM) in the Wenatchee subbasin during the period 1960 to 1999. Spawner numbers include both hatchery (minus those in Icicle Creek) and naturally produced fish.

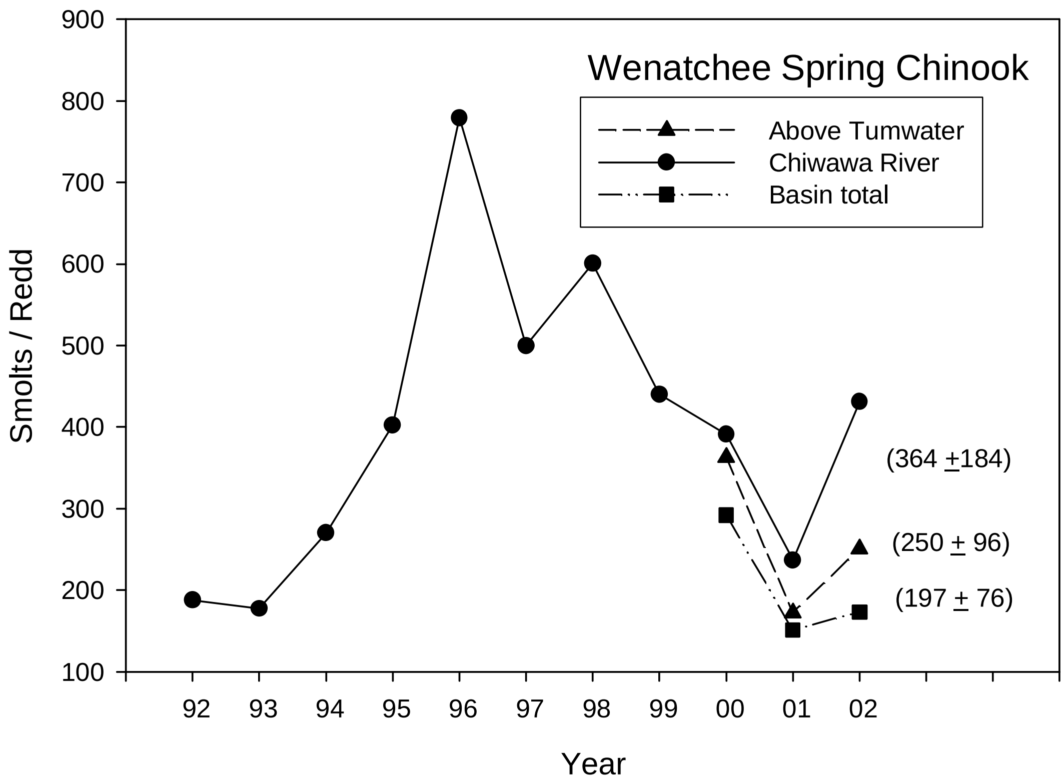


Figure 2.2 Annual smolts per redd for Wenatchee River spring Chinook. The numbers to the right of the lines are the geometric means (± 1 SD).

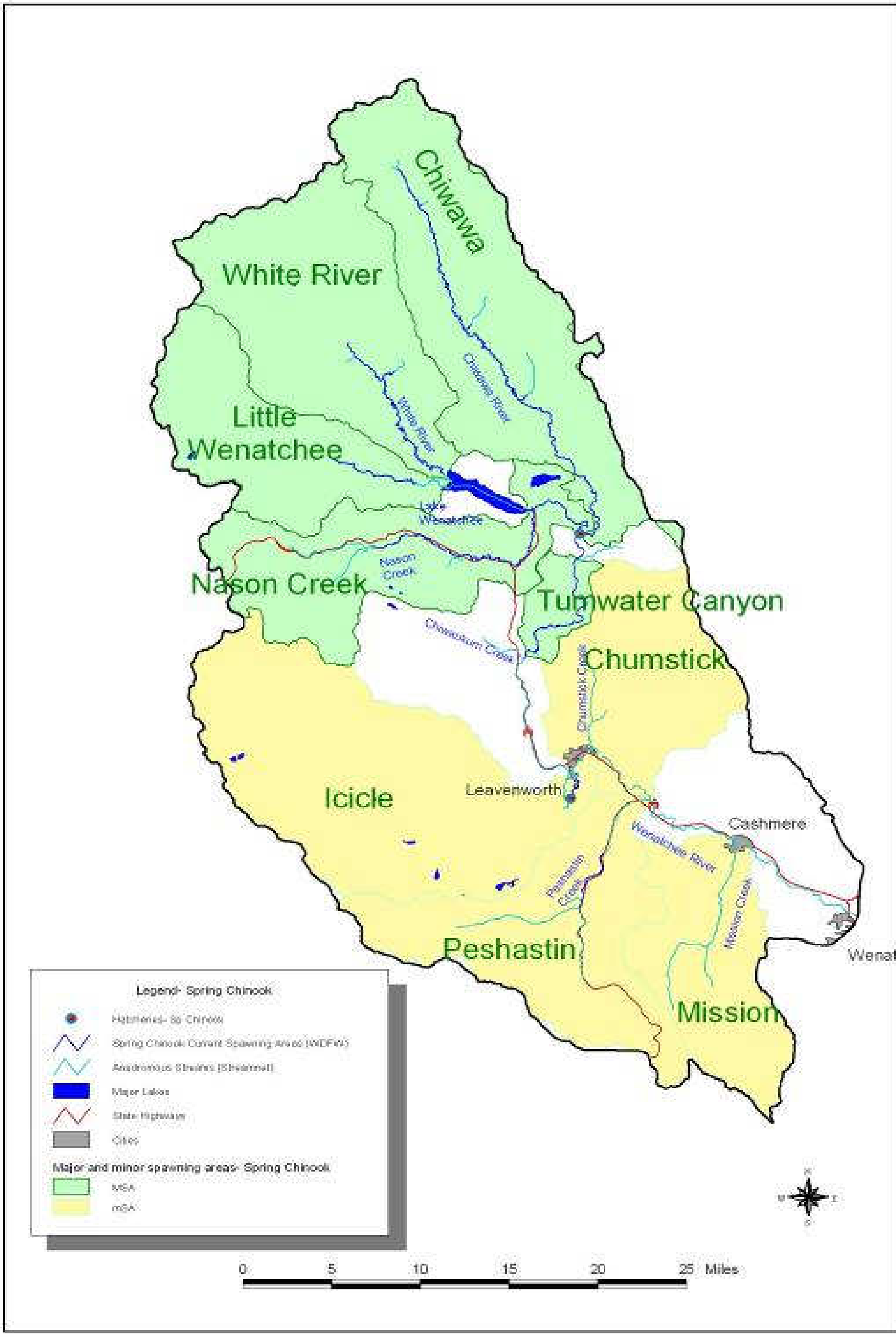


Figure 2.3 Current and potential distribution of spring Chinook in the Wenatchee subbasin

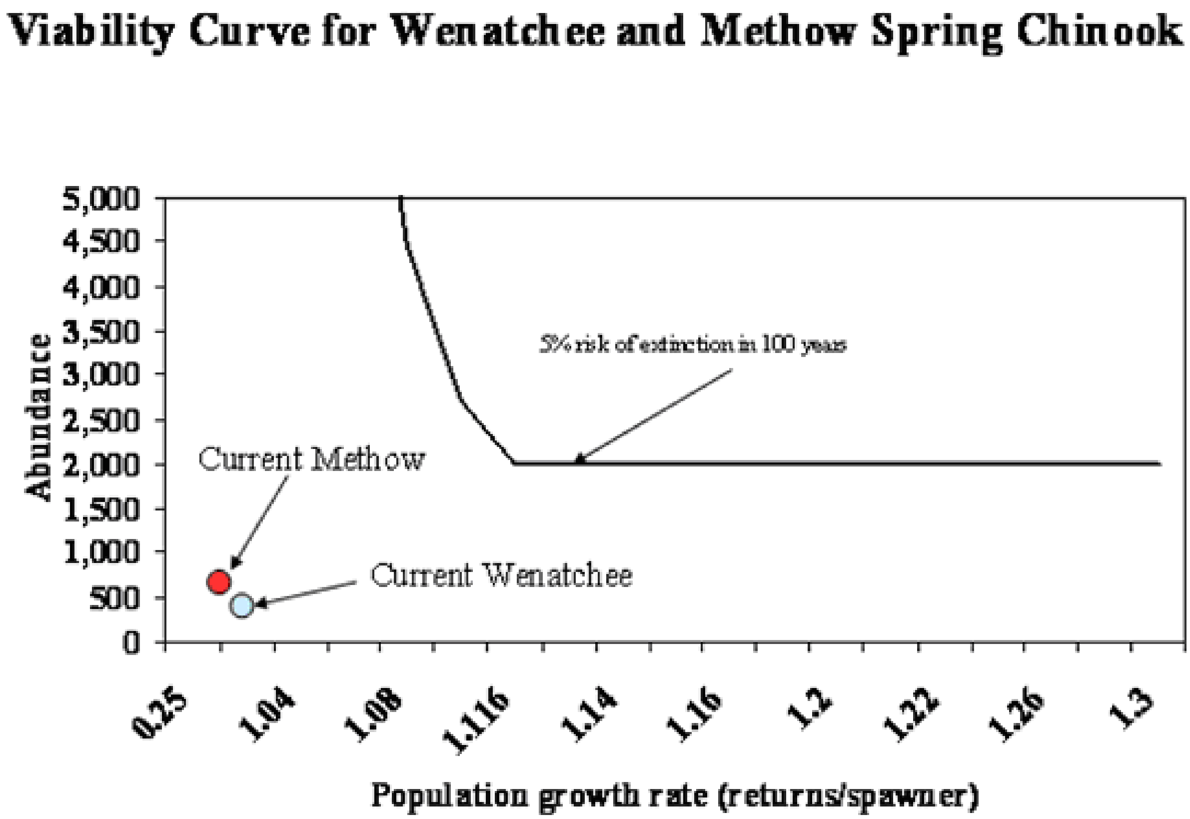
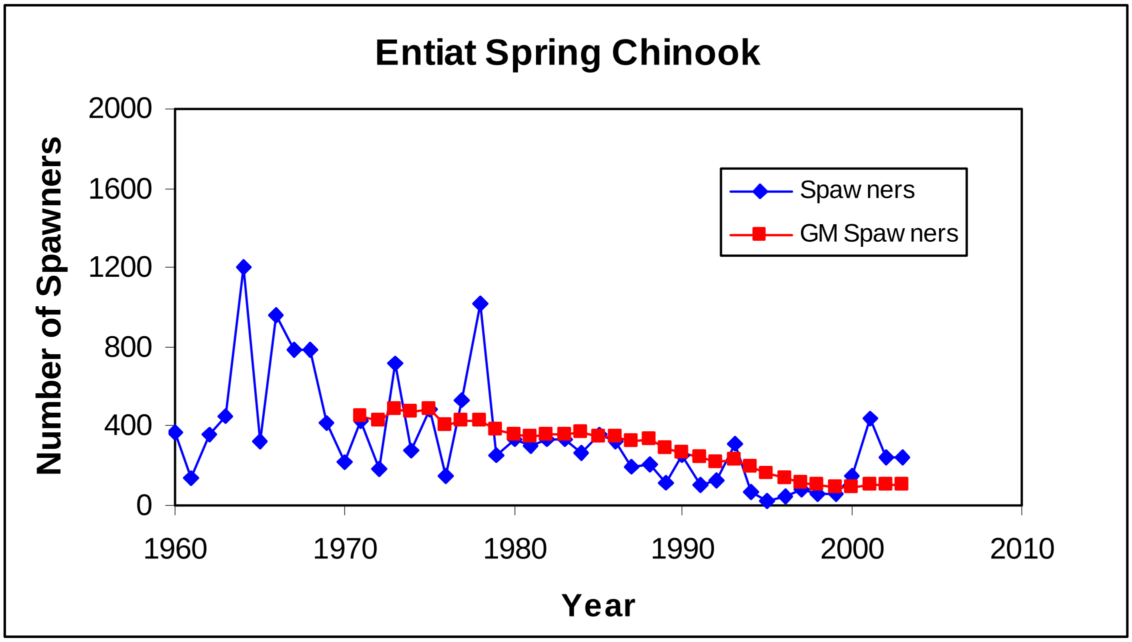


Figure 2.4 Viability curve for Wenatchee and Methow spring Chinook salmon. For the Wenatchee and Methow populations to be viable, their abundance/productivity scores must fall above the viability curve. Variability should be considered as the abundance/productivity estimates approach viability criteria. Viability curve is from the ICBTRT (2005a). This plan recognizes that as abundance and productivity values approach the minimum viability thresholds it will be necessary to incorporate uncertainty and measurement error regarding the status of each population.



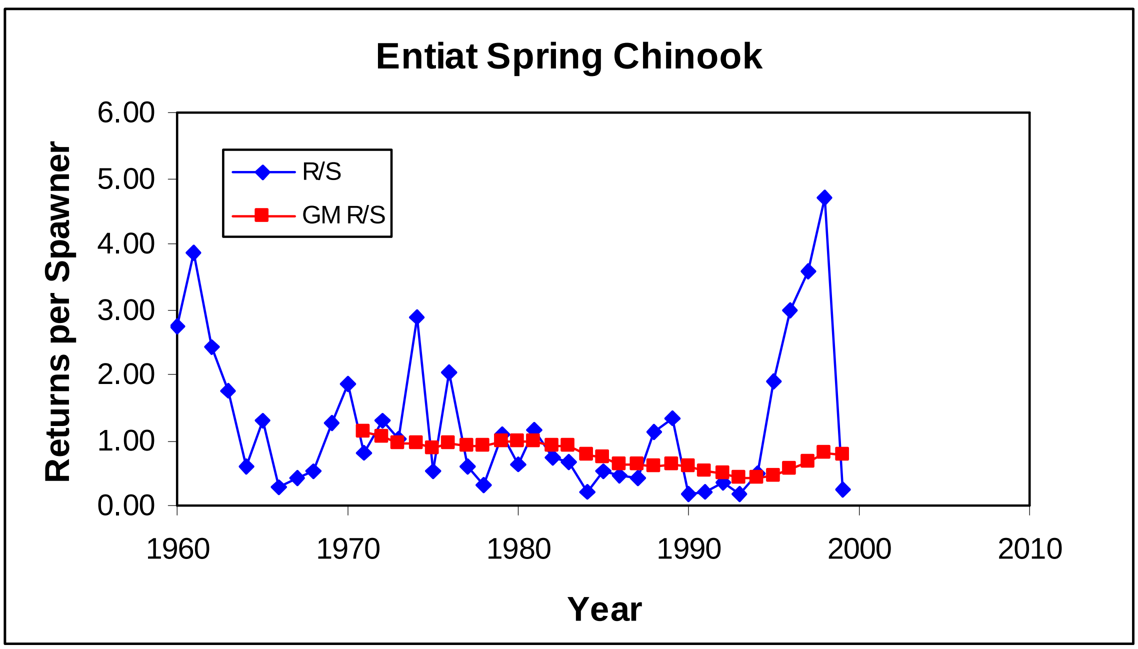


Figure 2.5 Spring Chinook spawners and returns per spawner (R/S) and their 12-year geometric means (GM) in the Entiat subbasin during the period 1960 to 1999. Spawner numbers include both hatchery and naturally produced fish.

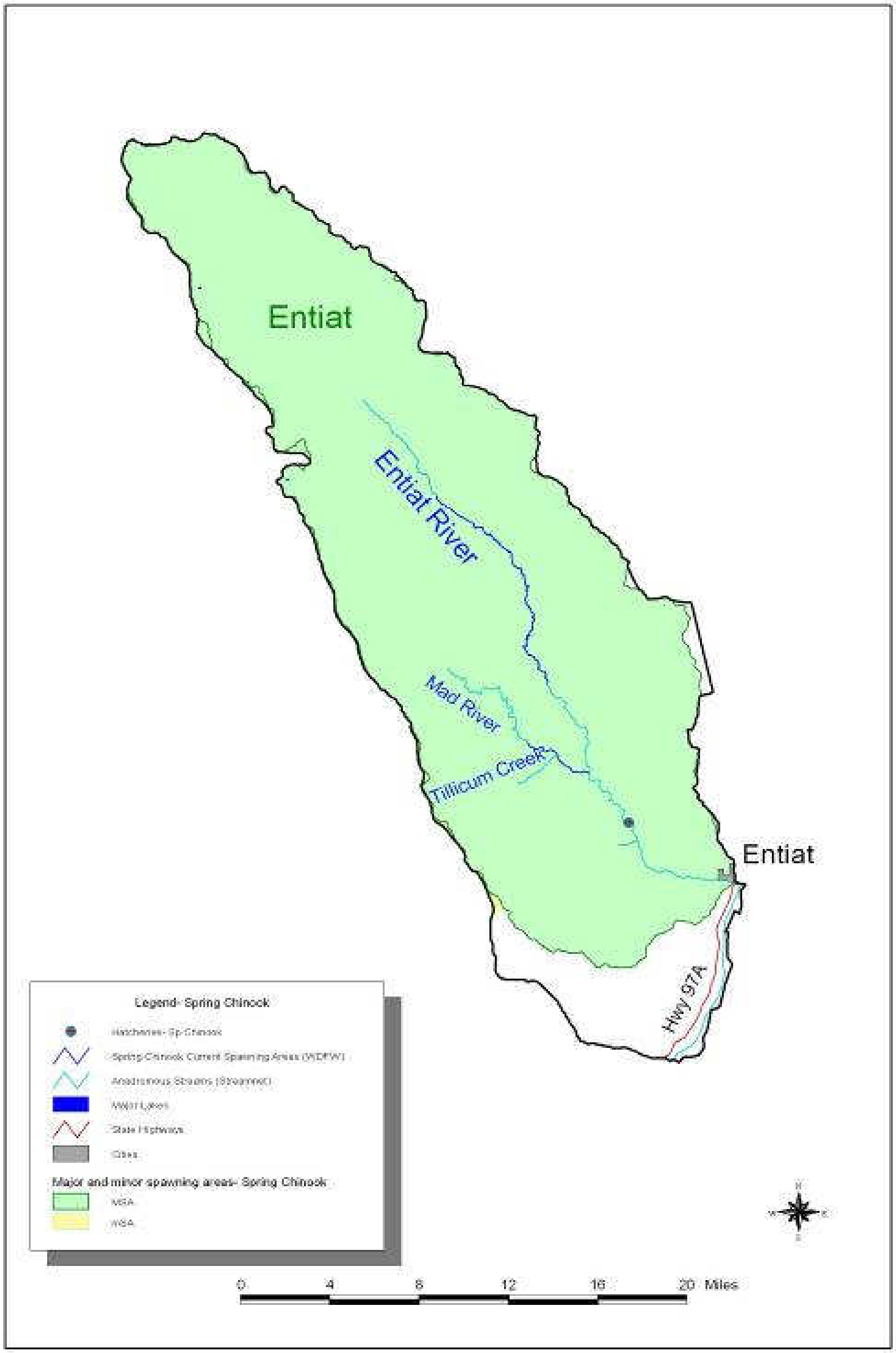


Figure 2.6 Current and potential distribution of spring Chinook in the Entiat subbasin

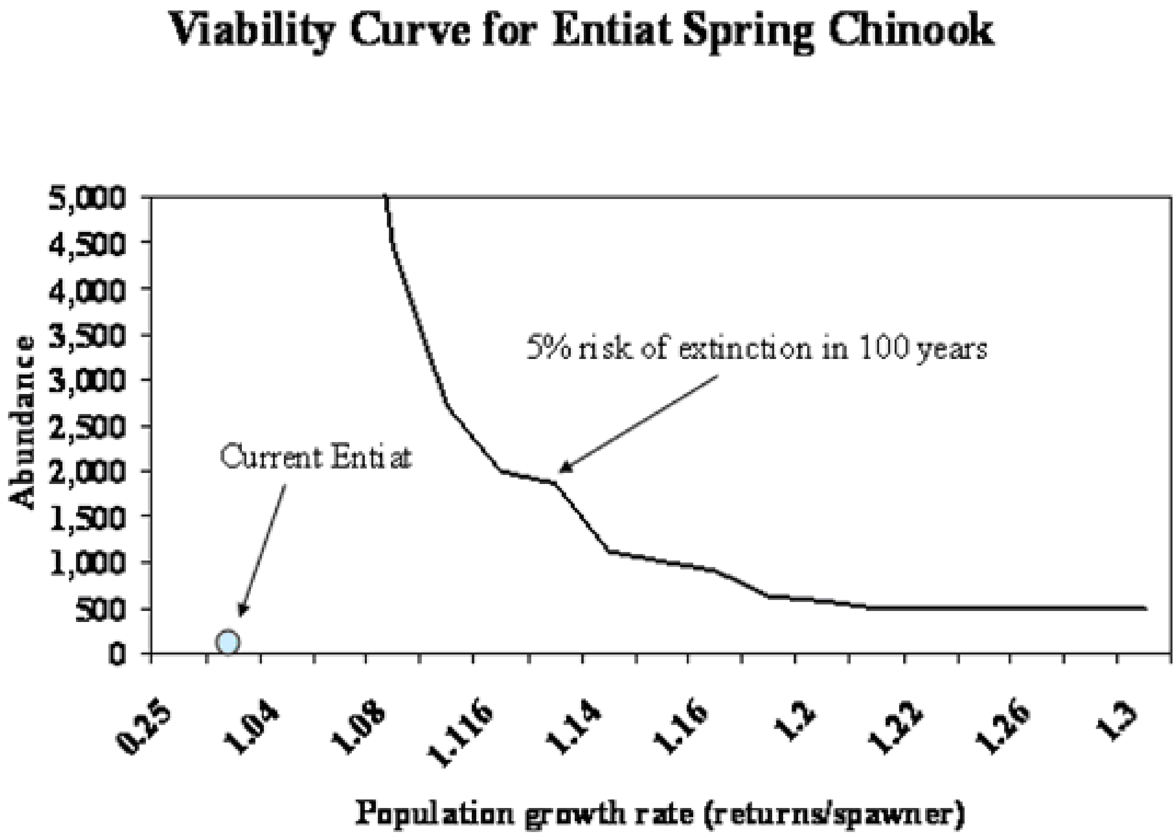
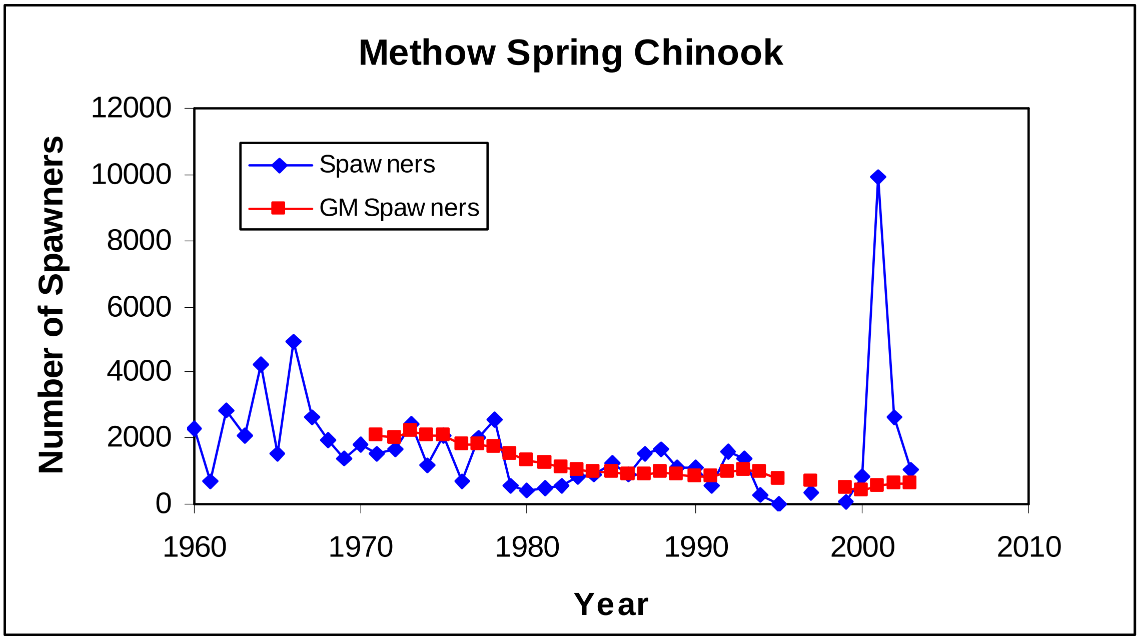


Figure 2.7 Viability curve for Entiat spring Chinook. For the Entiat population to be viable, its abundance/productivity score must fall above the viability curve. Variability should be considered as the abundance/productivity estimates approach viability criteria. Viability curve is from the ICBTRT (2005a). This plan recognizes that as abundance and productivity values approach the minimum viability thresholds it will be necessary to incorporate uncertainty and measurement error regarding the status of each population.



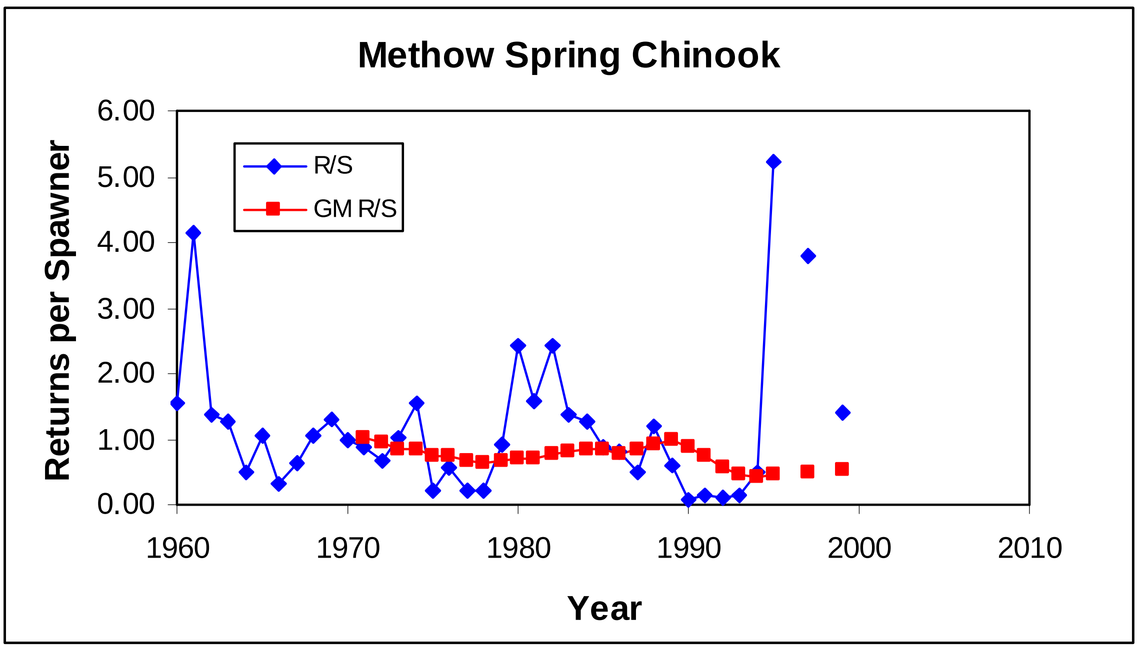


Figure 2.8 Spring Chinook spawners and returns per spawner (R/S) and their 12-year geometric means (GM) in the Methow subbasin during the period 1960 to 1999. It is assumed that all spawners in 1996 and 1998 were collected for hatchery broodstock. Spawner numbers include both hatchery and naturally produced fish.

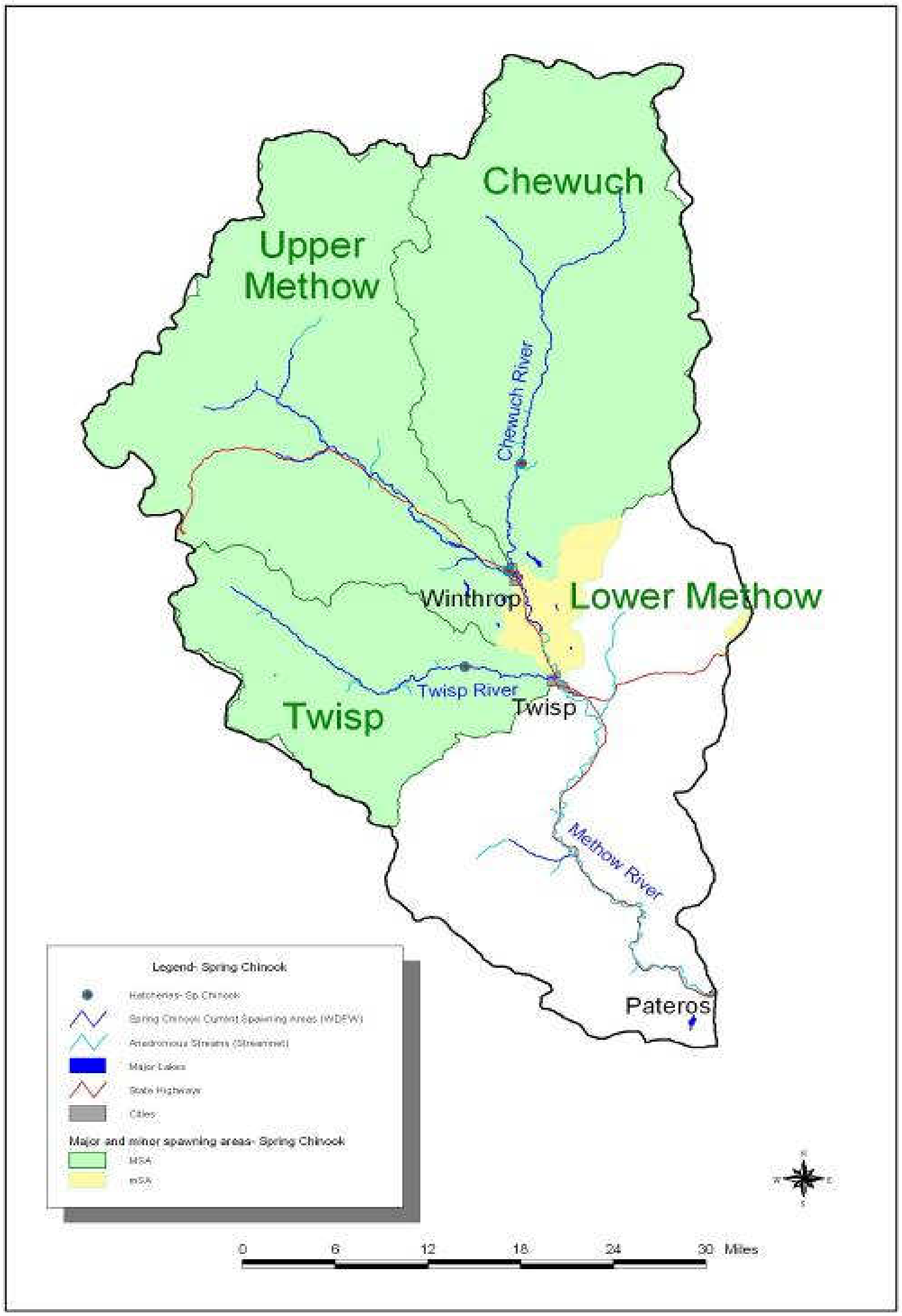


Figure 2.9 Current and potential distribution of spring Chinook in the Methow subbasin

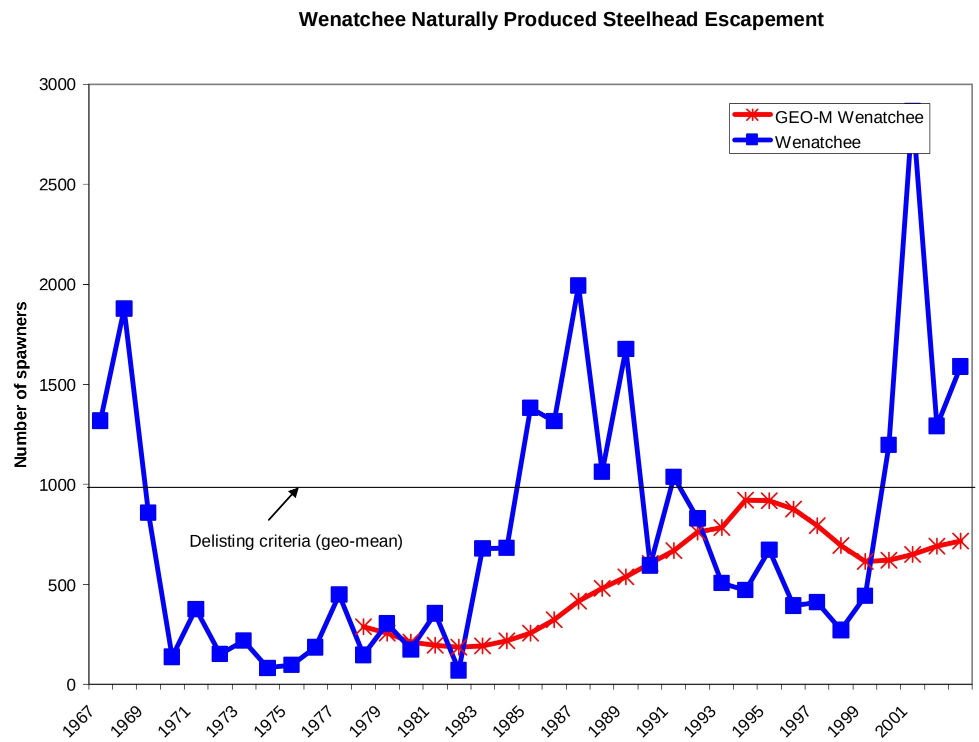


Figure 2.10 Escapement of naturally produced steelhead in the Wenatchee subbasin

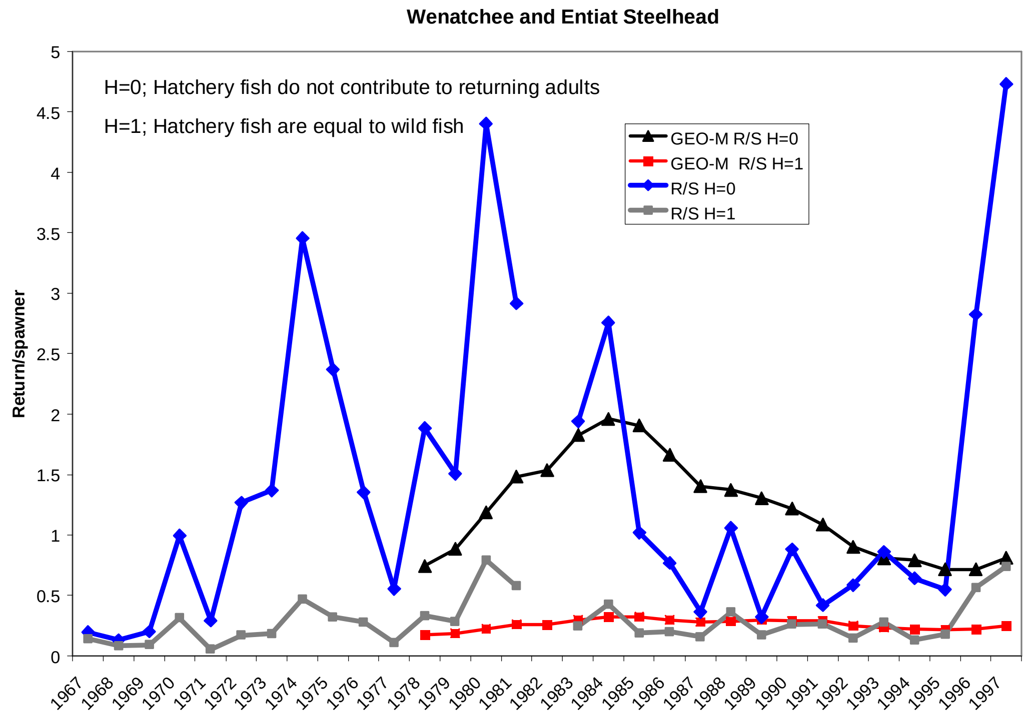


Figure 2.11 Returns per spawner (R/S) of naturally produced steelhead in the Wenatchee and Entiat subbasins. Returns per spawner are shown for hatchery fish that are as reproductively successful as naturally produced fish (H = 1) and hatchery fish that have no reproductive success (H = 0)

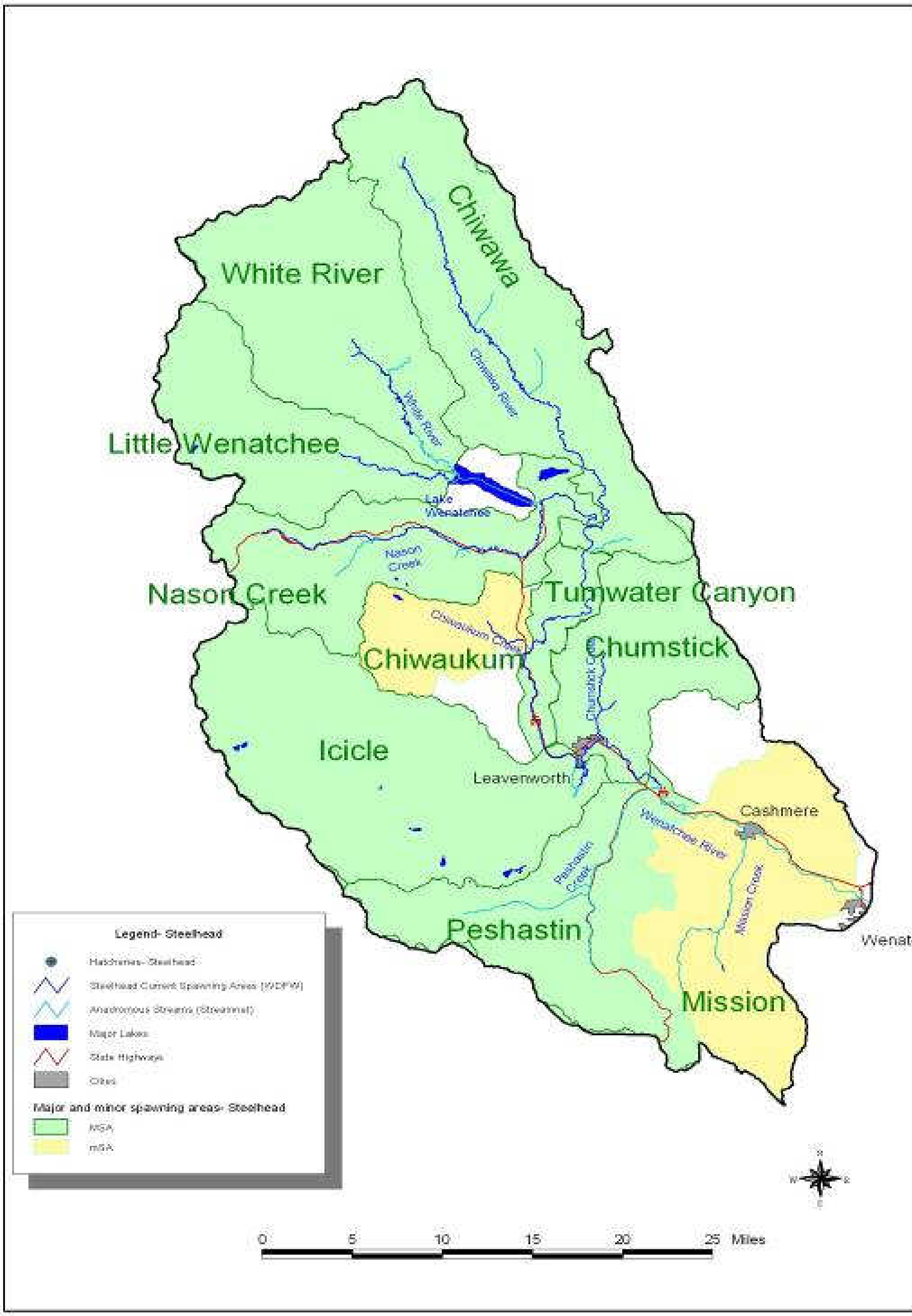


Figure 2.12 Current and potential distribution of steelhead in the Wenatchee subbasin

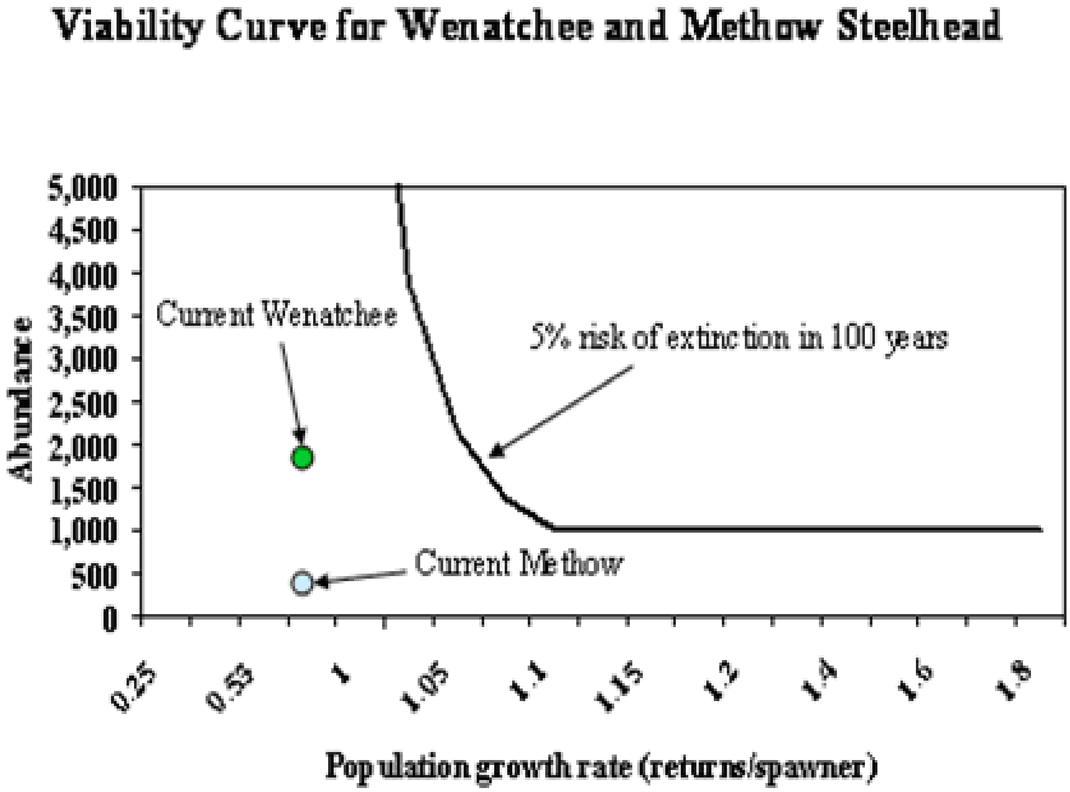


Figure 2.13 Viability curve for Wenatchee and Methow steelhead. This figure is based on the assumption that hatchery fish have no reproductive success. Variability should be considered as the abundance/productivity estimates approach viability criteria. Viability curve is from the ICBTRT (2005a). This plan recognizes that as abundance and productivity values approach the minimum viability thresholds it will be necessary to incorporate uncertainty and measurement error regarding the status of each population.

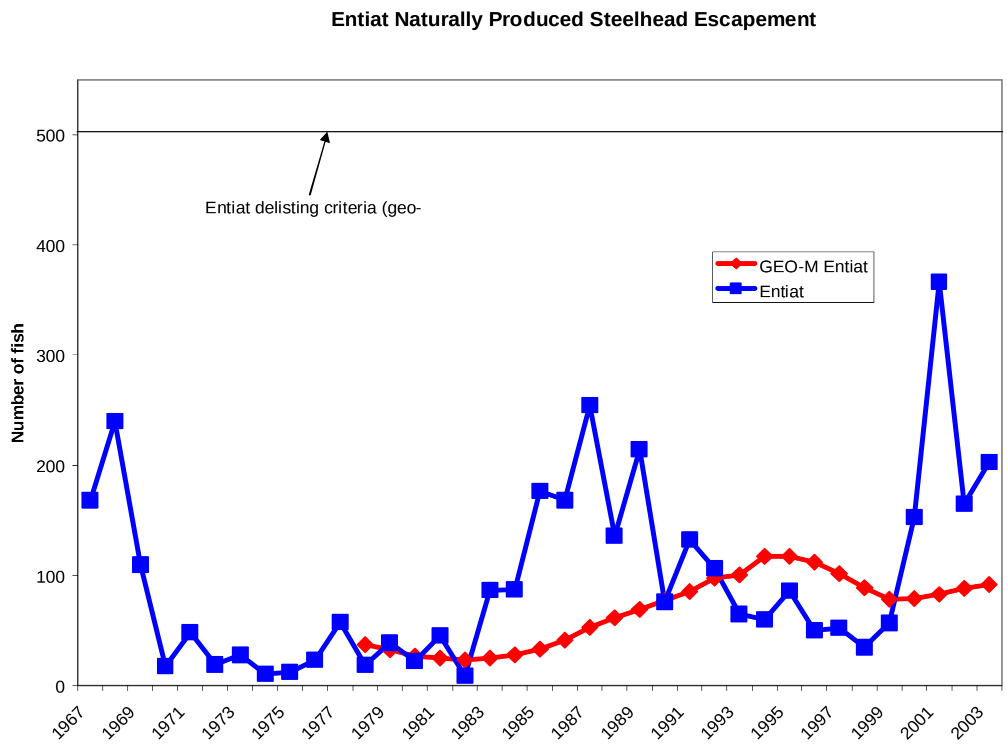


Figure 2.14 Escapement of naturally produced steelhead in the Entiat subbasin

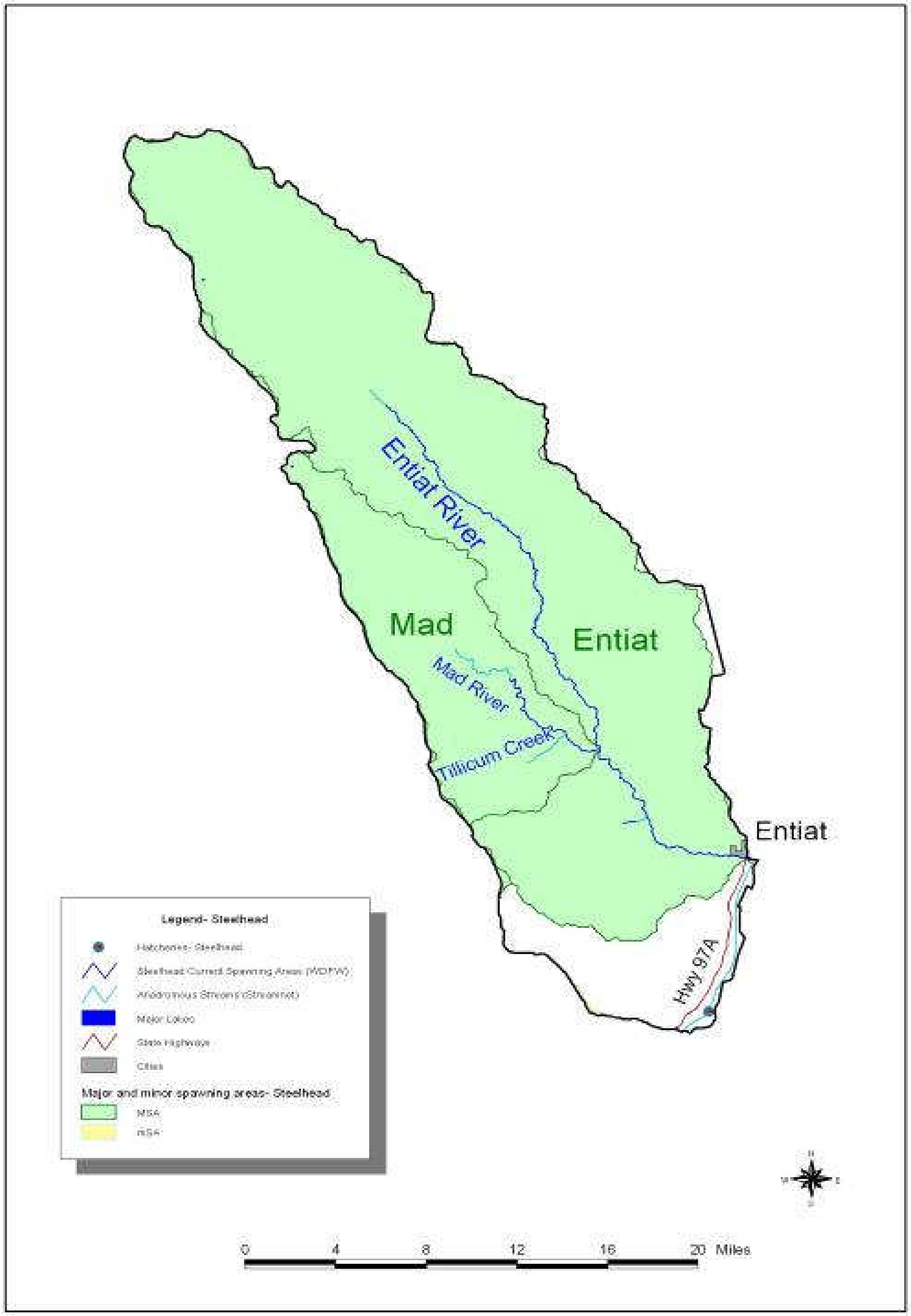


Figure 2.15 Current and potential distribution of steelhead in the Entiat subbasin

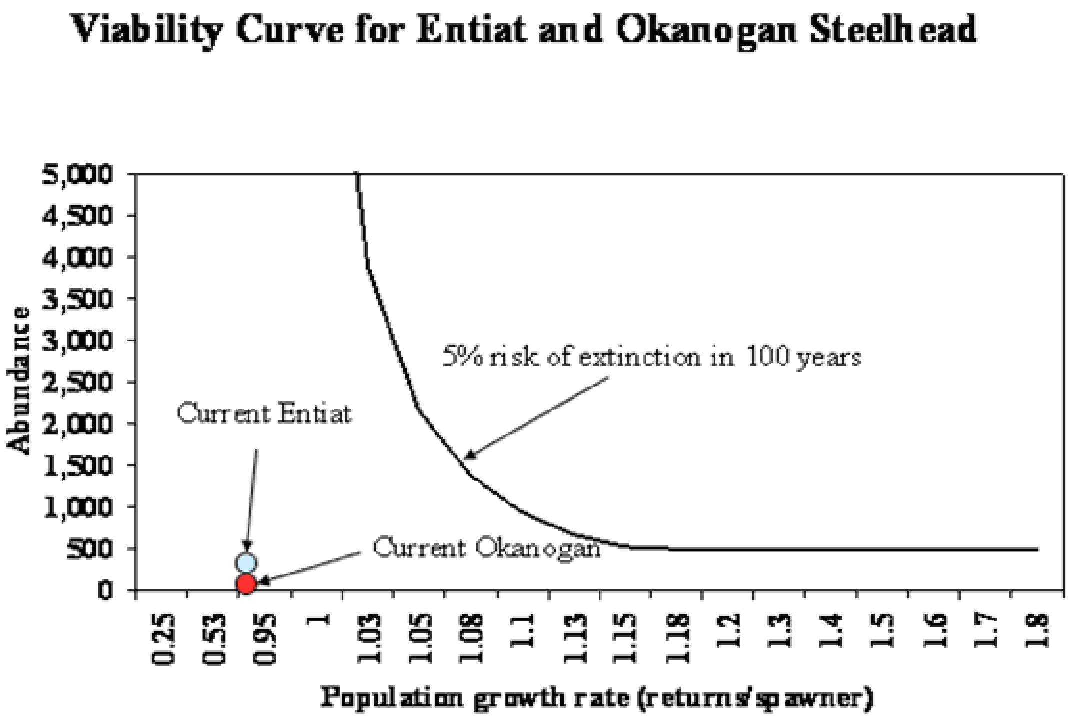


Figure 2.16 Viability curve for Entiat and Okanogan steelhead. Assumes hatchery fish have no reproductive success. Variability should be considered as the abundance/productivity estimates approach viability criteria. Viability curve is from the ICBTRT (2005a). This plan recognizes that as abundance and productivity values approach the minimum viability thresholds it will be necessary to incorporate uncertainty and measurement error regarding the status of each population.

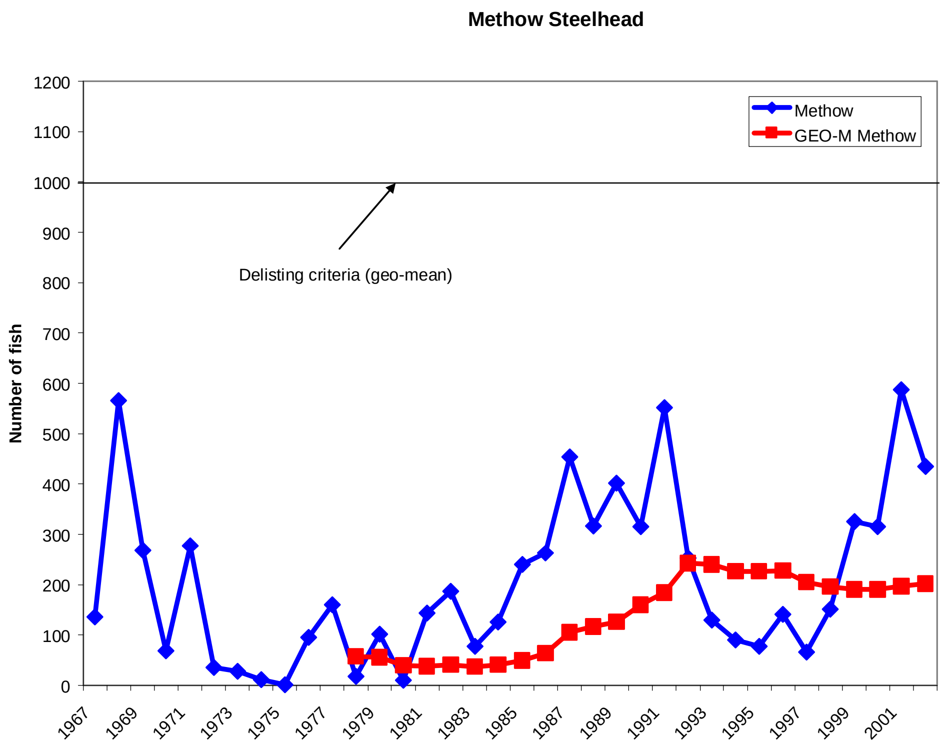
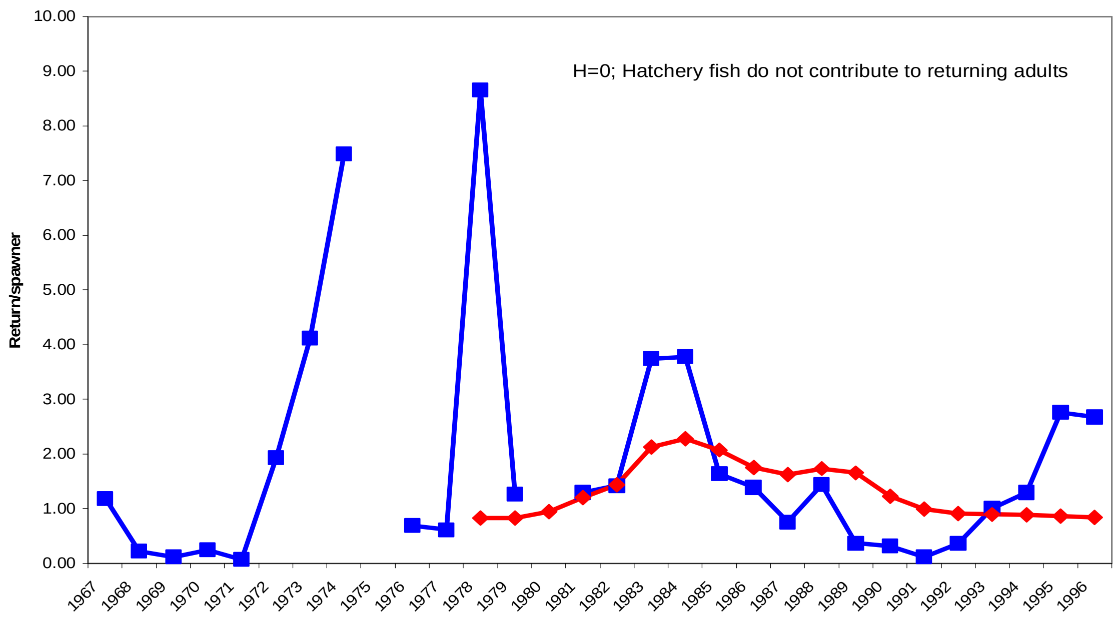


Figure 2.17 Escapement of naturally produced steelhead in the Methow subbasin

Methow and Okanogan Steelhead



Methow and Okanogan Steelhead

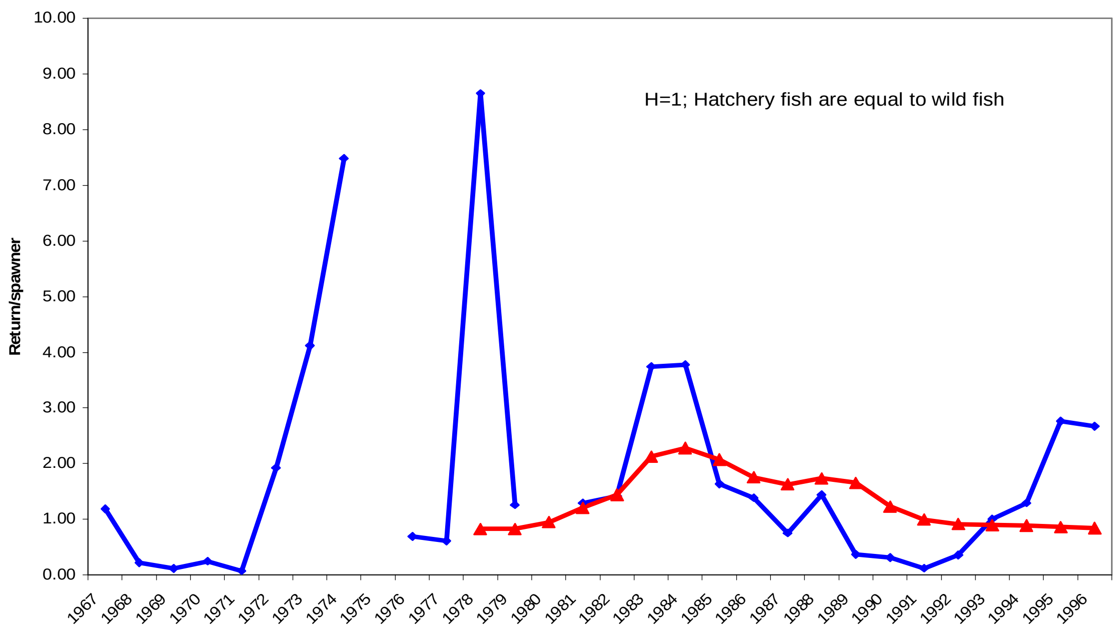


Figure 2.18 Returns per spawner of naturally produced steelhead in the Methow and Okanogan subbasins. Returns per spawner are shown for hatchery fish that have no reproductive success (H = 0) and hatchery fish that are as reproductively successful as naturally produced fish (H = 1).

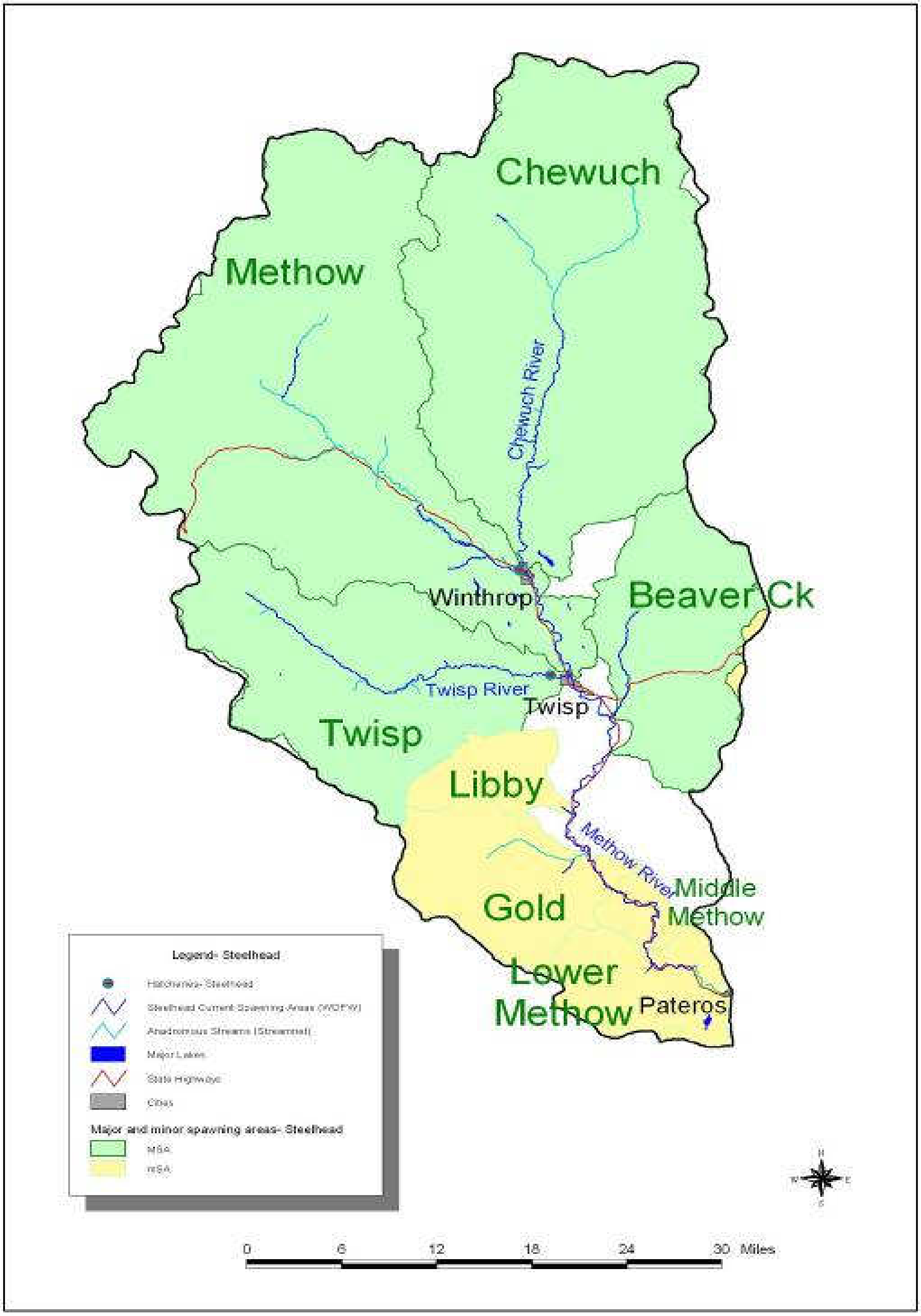


Figure 2.19 Current and potential distribution of steelhead in the Methow subbasin

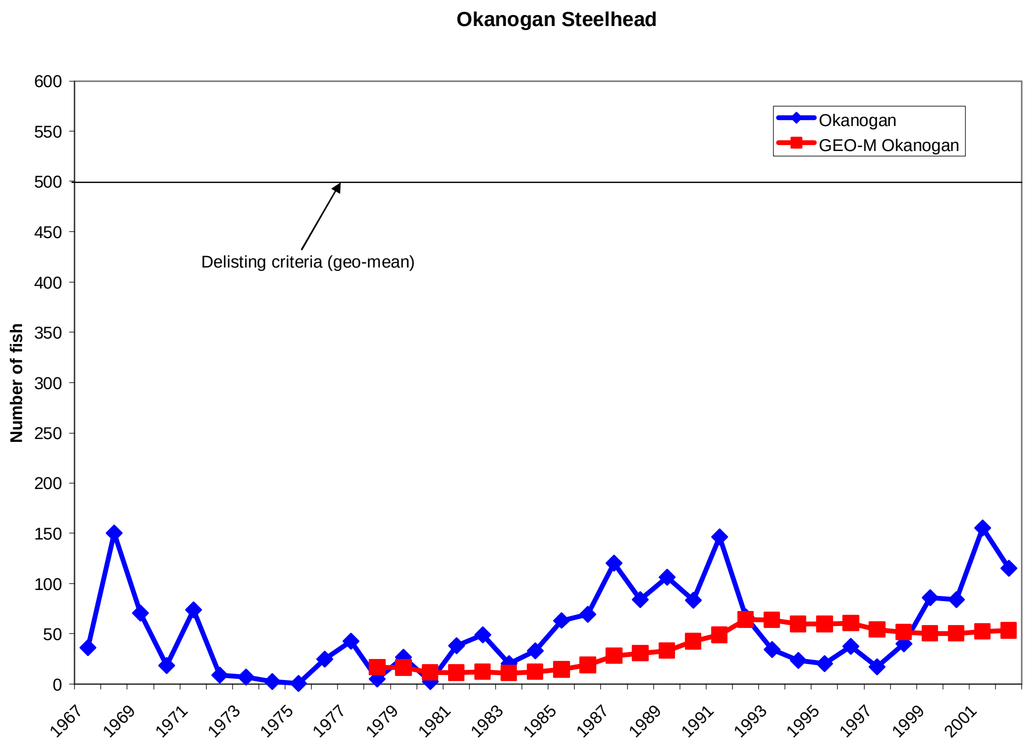


Figure 2.20 Escapement of naturally produced steelhead in the Okanogan subbasin

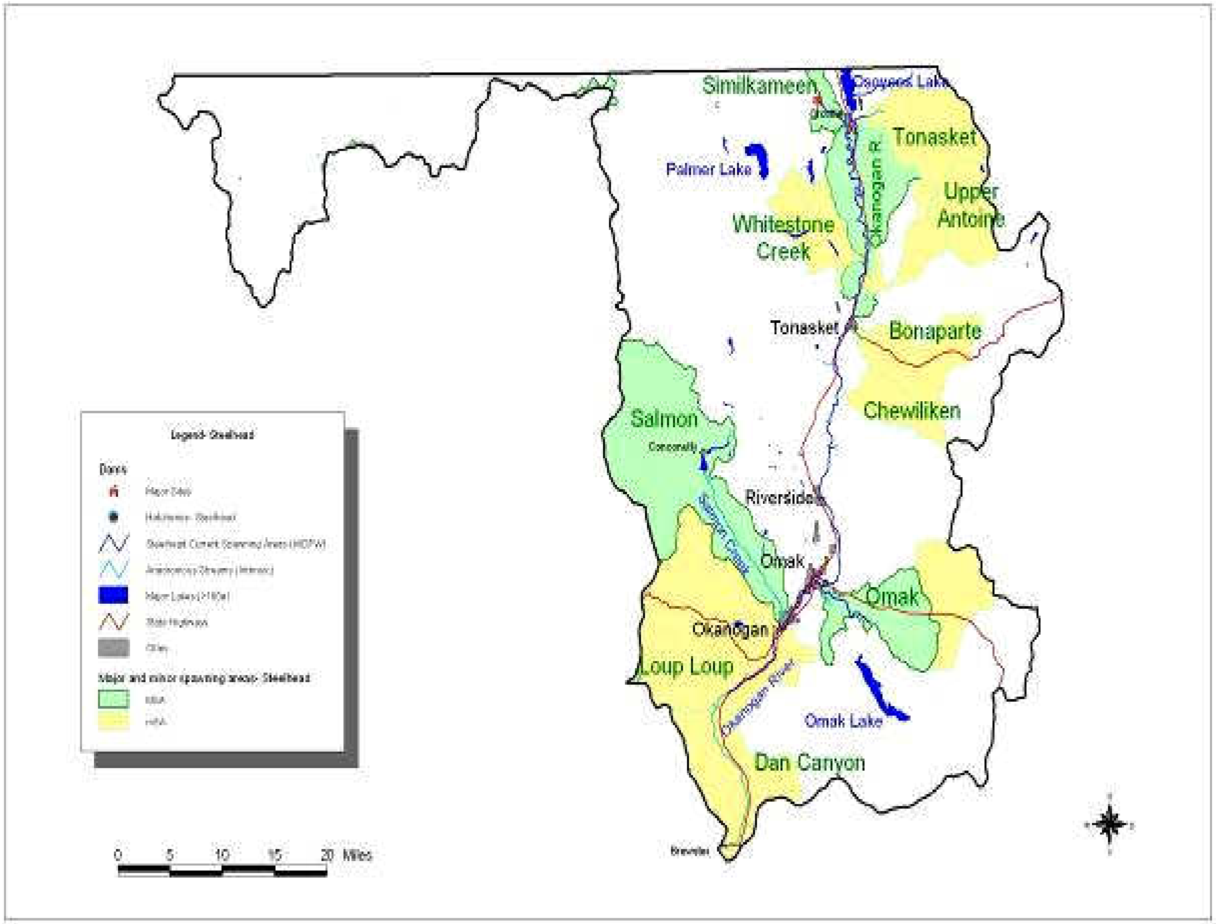


Figure 2.21 Current and potential distribution of steelhead in the U.S. portion of the Okanogan subbasin

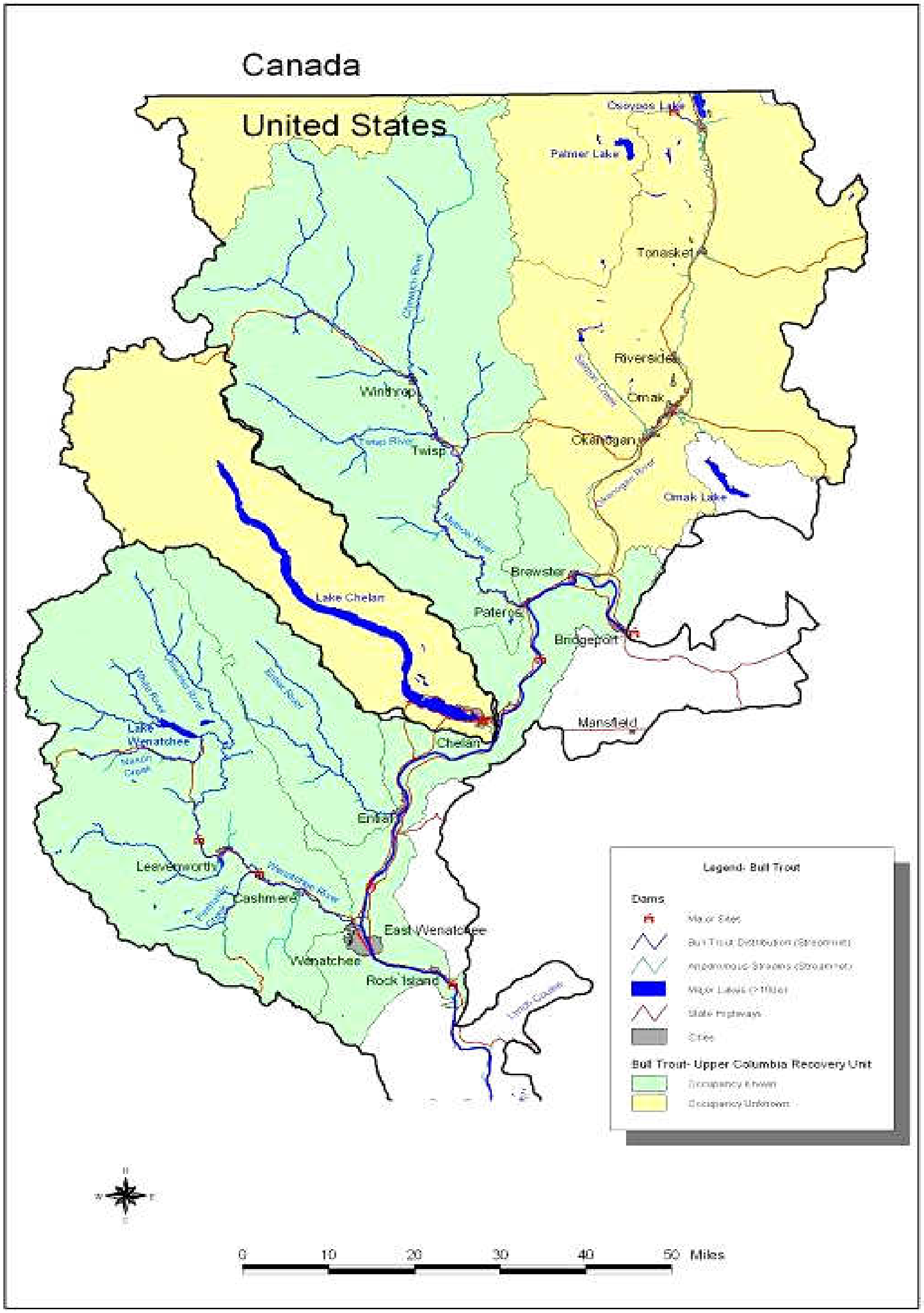


Figure 2.22 Current and potential distribution of bull trout in the Upper Columbia Basin

3 Factors for Decline

Historic and current human activities and governmental policies acting in concert with natural events have affected abundance, productivity, spatial structure, and diversity of Upper Columbia spring Chinook salmon, steelhead, and bull trout populations. A brief discussion follows of factors that limit the abundance, productivity, spatial structure, and diversity of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. A more detailed discussion can be found in the Bull Trout Draft Recovery Plan (USFWS 2002), watershed plans, and subbasin plans.

3.1 Social, Cultural, and Economic Factors

Humans, salmon, and trout colonized and expanded their range in the Columbia River Basin after the most-recent Ice Age (10,000-15,000 years BP). Native Americans developed a culture that relied extensively upon anadromous fish for sustenance in some portions of the area (Craig and Hacker 1940). Their catches increased as their populations rose and techniques of fishing developed. Native Americans captured large numbers of fish for both sustenance and trade, particularly at partial obstacles for fish passage. Their religion, heritage, and economy centered on salmon and other native species.

Native Americans in the Upper Columbia Basin generally had access to an abundant fish resource comprised of spring, summer, and fall runs of Chinook salmon, coho, and sockeye, and steelhead/rainbow as well as bull trout, cutthroat trout, Pacific lamprey, suckers, and white sturgeon. Historically, populations within the Columbia Basin varied widely from year to year and may have ranged from 6-16 million salmon and steelhead (Chapman 1986; NPPC 1986). Estimates of pre-development salmon and steelhead numbers were based on maximum catches in the latter part of the 1800s and assumed catch rates by all fishing gear. Inherent in such calculations is the assumption that fish populations in the 1800s represented a reasonable expression of average effects of cyclic variation in freshwater and ocean habitat conditions. Annual peak catches in the 1800s by all fishers may have included 3-4 million salmon and steelhead (Chapman 1986). Total run size for all salmon and steelhead recently (since 1980) has ranged from 1 to 2 million fish. About three-quarters of recent spring Chinook and summer steelhead runs have consisted of fish cultured to smolt size in hatcheries.

Bull trout have also experienced a reduction in abundance and distribution within their historical range in the coterminous (lower 48 states) United States (USFWS 2002). Throughout their historic range there have been local extirpations (e.g., Coeur d'Alene River Basin). Even in the absence of reliable historical population estimates, it is reasonable to assume that bull trout in the Upper Columbia Basin are less abundant today than they were historically. For example, bull trout are believed to be functionally extirpated in the Lake Chelan and Okanogan subbasins (i.e., few individuals may occur there but do not constitute a viable population). The USFWS (2002) considers bull trout in the Chelan and Okanogan subbasins as "occupancy unknown." Consequently, they are currently less widely distributed in the Upper Columbia Basin than they were historically.

Several social/economic factors depressed numbers of spring Chinook, steelhead, and bull trout sufficiently to lead to ESA listing. With regard to salmon and steelhead, Lackey (2001) wrote:

> The depressed abundance of wild stocks was caused by a well known but poorly understood combination of factors, including unfavorable ocean or climatic conditions; excessive commercial, recreational, and subsistence fishing; various farming and ranching practices; dams built for electricity generation, flood control, and irrigation, as well as many other purposes; water diversions for agricultural, municipal, or commercial requirements; hatchery production to supplement diminished runs or produce salmon for the retail market; degraded spawning and rearing habitat; predation by marine mammals, birds, and other fish species; competition, especially with exotic fish species; diseases and parasites; and many others. Technocrats continue to vigorously debate what proportion of the decline is attributable to which factor.

3.2 Public Policy

Public policy is a course of governmental action or inaction in response to social and environmental problems. It is expressed in goals articulated by political leaders in formal statutes, rules, and regulations; and in the practices of administrative agencies and courts charged with implementing or overseeing programs. Some policies can have negative effects on the survival of salmon, steelhead, and bull trout. For example, early efforts by the Corp of Engineers to minimize the effects of floods included diking, channelization, and removal of woody debris. These efforts reduced habitat diversity and species productivity. Another example that negatively affected the viability of bull trout included the directed bull trout fishery (reduction program) by the Washington Department of Game (WDG) in the region.

The Marine Mammal Protection Act of 1976 afforded pinnipeds (seals and sea lions) protection from killing by humans. These animals increased sharply in abundance thereafter (Fresh 1996). The National Research Council (NRC 1996) discussed the potential for effects on salmon and steelhead. They concluded that such predation was "probably not a major factor in the current decline of salmon in general." However, in some years about 50% of the salmon and steelhead in the Snake River show markings or scars that could be attributed to pinnipeds (from Fish Passage Center weekly reports). Although pinnipeds and salmon coexisted long before man interfered ecologically, human alterations and management practices throughout the species range have resulted in a reduction in salmon and steelhead abundance to the point that increased or targeted predation can have more significant effects on population viability.

As another example, the Corps of Engineers dredges shipping channels in the lower Columbia River and has created artificial islands with the spoils. Caspian terns have exponentially increased in the Columbia River estuary after dredge spoils created near-ideal nesting sites within the boundaries of a USFWS refuge. Many PIT tags have been found on artificial island sites, demonstrating that terns may be very important predators on smolts that must pass through the estuary to reach the sea.

Public policy clearly has more ubiquitous influences, both direct and indirect, than the foregoing examples (NRC 1996). Mainstem dams are a direct outgrowth of public policy, constructed by the federal government (Chief Joseph, Grand Coulee, and four mainstem Columbia River dams downstream from the Snake River) or by public utilities licensed by the Federal Energy Regulatory Commission (Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids dams).

The Washington State Office of Financial Management has projected that human population growth will nearly double in the next two decades in many areas in the Upper Columbia region, placing further pressure on natural resources and the environment (http://www.ofm.wa.gov/pop/gma/). Local governments apply these projections as they relate to their planning population allocation to urban growth areas and rural lands.

3.2.1 Local Government Policies, Regulations, and Programs

The local governments (cities, towns, counties, and Colville Tribes) in the Upper Columbia Region have a significant role in the development, adoption, implementation, and enforcement of land-use regulations that address existing and future threats to listed species. In Washington State, land-use planning and a wide array of environmental protection programs are mandated at the state level, but developed, adopted, and implemented at the local level (e.g., counties, cities, and towns). The same is generally true with the Colville Tribes, although their statutory authority is derived from federal regulations and related obligations. This means that threats to recovery of listed species from future development, land uses, and land and facilities management activities can be best addressed by local governments and the Tribes, including criteria regarding development, adoption, implementation, monitoring, and enforcement of land use and environmental protection regulations that affect the habitat of listed species.

Local government programs and regulations that potentially affect listed species can be divided into the following categories:

- Comprehensive Plans (land use, water, wastewater, stormwater, sold waste, etc.)
- Implementing Regulations (zoning, critical areas, shorelines, development standards, etc.)
- Permitting Processes (conditional use, substantial development, building, variance, exemptions, etc.)
- Code Enforcement/Compliance
- Environmental Review (SEPA and NEPA)

The local governments in the Upper Columbia Region and Tribes have numerous policies, regulations, and programs that are designed to avoid or minimize impacts to the environment from activities associated with human land use and management activities. The decline in salmon and trout habitat has resulted from numerous diverse human activities and natural processes over a biologically short period of time. Many of the activities that contributed to decline in salmon habitat conditions occurred before current policies, regulations, and programs were enacted. Therefore, the existence of degraded habitat does not necessarily mean that local government and Tribal policies, regulations, and programs are inadequate, as most were non-existent during the period of decline. However, as part of the recovery planning process, a review of programs that are now in place was undertaken to determine if either compliance or implementation can be improved to aid in recovery.

The review process began by generating a list of specific plans, programs, and activities under the purview of local governments. For each plan, program, and activity, their purpose was described and their relationships to recovery of listed species, VSP parameters, and ESA threats criteria were evaluated (Appendix D). The review process found that most of the local governments in the region are either in compliance or are actively working on obtaining compliance on a wide array of state and federal programs aimed at protecting, restoring, and enhancing the environment (Appendix D).

3.3 Management Actions

Golder Associates (2004) recently compiled a list of management programs related to fish and wildlife from 25 federal, state, and local agencies and governments in the Upper Columbia basin. They gathered the information through a review of existing documents and websites, and through direct contact with agencies. Management programs, sponsors or lead agencies, area affected by the program, the goal of the program, and a determination of the threats of the program to Chinook, steelhead, and bull trout are listed in Appendix E.

In sum, there are at least 132 management programs and projects being implemented in the Upper Columbia Basin. If the programs are implemented correctly and monitored for compliance, most of the programs (103 programs) promote the survival of spring Chinook, steelhead, and bull trout; 16 should have no effect or may promote survival.[47] Thirteen programs may threaten the viability of Chinook, steelhead, and bull trout in the Upper Columbia Basin. All hatchery programs have the potential to threaten viability by reducing the diversity of locally derived stocks. For example, the Entiat and Leavenworth National Fish Hatchery programs use out-of-basin stocks, which if stray into natural spawning areas, may affect the diversity and perhaps spawning success of naturally produced spring Chinook and steelhead (see Section 3.5). On the other hand, hatchery programs may also support recovery by increasing abundance of listed species. The U.S. Bureau of Reclamation (BOR) and the Army Corps of Engineers (ACOE) have programs that may threaten the viability of Chinook, steelhead, and bull trout populations. The Chief Joseph Dam Project (ACOE) and the Okanogan Project (BOR) probably affected or may affect spatial structure and productivity by reducing connectivity and decreasing stream flows needed for rearing and spawning. Programs that are designed to protect property and lives from flood damage can decrease viability of populations by decreasing habitat diversity and complexity. This plan does not advocate programs that could result in loss of property or

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[47] Threats to viability were determined by asking two general questions: (1) does the program affect the biology of Chinook, steelhead, and bull trout and (2) does the program affect the environment in which the fish live? Issues considered under the biology of the fish included affects to abundance, spatial structure, genetics, fecundity, survival, habitat use, and community structure. Issues considered under the environment included affects to water quality, flows and hydrology, habitat access, habitat quality, channel condition, riparian condition, and watershed condition. If a given program could negatively affect any of these attributes, the program was considered a possible threat to the viability of the fish.

lives. The point here is that some of these programs are not necessarily consistent with measures for establishing viable fish populations.

A management practice that deserves to be highlighted is the introduction of exotic fish species into the Upper Columbia Basin. Of the approximately 41 fish species in the Upper Columbia Basin, 16 are exotics (see Section 2.2). One species, brook trout, threatens the viability of bull trout in the Upper Columbia Basin. Brook trout are well established in several streams in the Wenatchee, Entiat, Lake Chelan, Methow, and Okanogan subbasins. Hybridization between brook trout and bull trout has been observed in the Chiwawa Basin and in Icicle Creek (T. Hillman, BioAnalysts, personal observation). Hybridization "pollutes" the bull trout gene pool and can result in offspring that are often sterile. Brook trout can also displace bull trout from rearing areas. In some streams (e.g., Big Meadow, Beaver, and Eightmile creeks), brook trout are so well established that they may have greatly reduced the numbers of bull trout in them (USFWS 2002). Current fishing regulations limit the harvest of exotic species. This protects exotic species and could be considered a threat as it reduces potential harvest of fish that compete or prey on ESA-listed species.

3.4 Harvest

It is unlikely that aboriginal fishing (pre-1930s) was responsible for spring Chinook and steelhead declines in the Columbia River (Craig and Hacker 1940; Chapman 1986; Lackey 1999). Their artisanal fishing methods (Craig and Hacker 1940) were incapable of harvesting Upper Columbia River spring Chinook and summer steelhead at rates that approached or exceeded optima for maximum sustained yield, probably 68% and 69% for spring Chinook and steelhead, respectively, as estimated in Chapman (1986).

Even the large aboriginal fishery in the upper reaches of the Columbia River did not significantly reduce the abundance of anadromous fish. The fishery at Kettle Falls, which is presently submerged under the waters of Lake Roosevelt, was second only to Celilo Falls in its overall ceremonial significance and productivity. In the 1800s, before establishment of commercial fisheries in the lower Columbia River, the combined aboriginal harvest of salmon and steelhead in the Upper Columbia River was estimated in excess of two million pounds annually (Koch and Cochran 1977).

Commercial fishing had a significant effect on the abundance of salmon and steelhead in the Columbia River. An intense industrial fishery in the lower Columbia River, employing traps, beach seines, gillnets, and fish wheels, developed in the latter half of the 1800s. In the early 1900s, troll fisheries developed to catch salmon even before they reached the Columbia River. The late-spring and early summer Chinook salmon returns, which constituted the heart of the Columbia River runs, were decimated by the early 1900s (Thompson 1951). As these run components rapidly declined, fishing shifted earlier, later, and to other species. These changes, for a time, numerically masked the precipitous decline in the sought-after late-spring and early summer fish.

By the early 1930s, mean escapement of spring Chinook into the Upper Columbia Basin upstream from Rock Island Dam had declined to fewer than 3,000 fish.[48] That escapement would represent perhaps 12,000 fish arriving in the lower Columbia River, inasmuch as fishing rates exceeded 75% in that period. Mean returns of steelhead to the Upper Columbia Basin were lower than 4,000 fish in the first part of the 1930s. Harvest rates of 70%, and probably higher, were common before the 1940s. If one assumes a 70% harvest rate, returns of Upper Columbia steelhead to the estuary may have amounted to about 13,000 fish.

By the 1930s and 1940s, restrictions on fishing time and gear had increased. For example, purse seines were outlawed in 1917, whip seines in 1923, fish wheels in 1927 (in Oregon), seines and traps east of Cascade Locks in Oregon in 1927, drag seines, traps, and set nets in 1935 (Washington), and seasons were gradually shortened. Catch rates almost certainly were much higher than those appropriate for maximum sustained yield for several decades before then. Presently, fishing rates have been reduced well below historical levels and approach about 12% for spring Chinook and 13% for steelhead.[49]

Intensive harvest not only affected abundance and productivity of fish stocks, but probably also the diversity of populations. Intense size-selective fishing is known to alter genetics of salmon with the result that adult size declines. Historically, intense gillnetting (a method that selectively captures larger fish) in the Columbia River may have increased the proportion of smaller fish in escapements, with potential increases in jack fractions and reduced fecundity of females. Three-ocean spring Chinook adults may have been selected against at earlier high fishing rates. Harvest may have truncated run-timing characteristics or separated runs into early and late components. Harvest also reduced escapements of adults into tributaries, resulting in a reduction of marine-derived nutrients into tributaries.

Fishing was likely an important factor leading to the decline of bull trout in the Upper Columbia Basin. Certain areas within the basin were targeted bull trout fisheries, and large numbers of bull trout were harvested (WDFW 1992). For example, bull trout were harvested commercially in Lake Chelan (Brown 1984). Currently, with the exception of a bull trout fishery on the Lost River, bull trout harvest is prohibited. Although bull trout harvest is prohibited, they are still vulnerable to take due to misidentification, hooking mortality, and poaching. Schmetterling and Long (1999) found that only 44% of anglers correctly identified bull trout, and anglers frequently confused related species (i.e., bull trout and brook trout). Incidental hooking mortality is known to vary from about 5% to 24% for salmonids caught on artificial lures, and between 16% and 58% for salmonids caught with bait (Taylor and White 1992; Schill 1996; Schill and Scarpella 1997). Bull trout are incidentally caught during the sockeye salmon fishery in Lake Wenatchee and also during open seasons for mountain whitefish (USFWS 2002). The effects of hooking mortality, incidental harvest, and poaching could be significant (Taylor and White 1992; Long 1997; Schmetterling and Long 1999).

[48] According to the Brennen Report (1938), many of the Chinook counted at Rock Island Dam were destined for spawning areas upstream from Grand Coulee Dam.

[49] These rates do not include indirect losses such as catch-and-release mortality, hook-and-loss mortality, and “shaker” loss. Indirect losses can range from 5-58% (Taylor and White 1992; Schill 1996; Schill and Scarpella 1997). Managers generally assume a 10% indirect loss.

3.5 Hatcheries

Presently, WDFW, USFWS, the Yakama Nation, and the Colville Tribes operate 22 artificial production programs in the Upper Columbia Basin, producing spring and summer Chinook, sockeye, coho, and steelhead. Twelve of these programs produce spring Chinook and steelhead. USFWS operates three and WDFW, the others. The three Federal hatcheries (Winthrop, Entiat, and Leavenworth hatcheries) were constructed as mitigation facilities to compensate for the lack of access and loss of spawning and rearing habitat caused by the construction of Grand Coulee Dam. At the time, it was estimated that 85-90% of the fish counted at Rock Island Dam originated upstream from Grand Coulee Dam. About half the spring Chinook ESU and steelhead DPS were taken out of production by these dams. These Federal hatcheries released co-mingled upriver stocks into the Wenatchee, Entiat, and Methow subbasins during the early 1940s. They also released out-of-basin stocks from the lower Columbia River into the Upper Columbia Basin.[50] Currently, the Winthrop National Fish Hatchery is the only federal hatchery in the Upper Columbia Basin that releases locally derived stock.[51] Hatcheries operated by WDFW are for supplementing existing stocks. These programs use locally derived stock for supplementation. Although hatcheries are an integral part of the hydro mitigation programs for the Upper Columbia, they are not intended to be a substitute for healthy, abundant spawning and rearing habitat.

Artificial production programs in the Upper Columbia Basin may have affected abundance, productivity, and diversity of naturally produced stocks in several different ways. The NRC (1996) and Flagg et al. (2001) discussed at length the risks and problems associated with use of hatcheries to compensate for, or supplement, fish produced in the wild. NRC (1996) noted demographic risk, pointing out that large-scale releases of hatchery fish exacerbate mixed-stock harvest problems, thereby reducing the abundance of naturally produced fish. Naturally produced fish cannot sustain harvest rates that would be appropriate for hatchery fish.

Measures used in the GCFMP and steelhead management in the Upper Columbia Basin (until recently) quite likely led to some of the listed risks and contributed to decreased genetic diversity of naturally produced fish. For example, steelhead adults were collected at Priest Rapids, and later at Wells Dam, their progeny reared in hatcheries and released as smolts to the various tributaries without regard to fostering local adaptation in tributaries. As another example, the similarity of DNA (deoxyribonucleic acid) collected from natural Entiat River spring Chinook and Entiat NFH samples indicates that Entiat NFH spring Chinook spawn successfully and have introgressed into or may have replaced the natural Entiat River population (Ford et al. 2004).

However, in the Ford et al. (2004) genetic study, the sample size was small and it only covered a limited number of years when spawning escapement of non-local origin hatchery fish was very high. Therefore, it is possible that the Entiat spring Chinook population could have less risk if genetic samples were evaluated over a longer time period with larger sample sizes.

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[50] The first out-of-basin stocks were released from early Washington Department of Fisheries hatcheries dating back to at least 1914 (Chapman et al. 1995).

[51] Locally derived stock refers to broodstock derived from a target population consisting of naturally produced fish and or hatchery produced fish derived from the naturally produced fish of the target populations.

An effect of hatcheries that is little studied, but one that may have affected the abundance and productivity of populations in the Upper Columbia Basin, is the assumed lower reproductive success of hatchery fish that spawn in the wild. That is, hatchery-reared fish that spawn in the wild often have a lower breeding success than naturally produced spawners. For example, Berejikian and Ford (2004) found that the relative reproductive success of hatchery-produced steelhead in an Oregon stream was as low as 2-13%.

Foraging, social behavior, time of spawning, and predator avoidance can differ for fish reared in the hatchery and in the wild (Flagg et al. 2001). While resulting differences may primarily reduce survival of hatchery-produced salmon and steelhead, negative effects may carry into a naturally produced population where adults of hatchery origin spawn with naturally produced fish. Effects of disease on released hatchery fish and on naturally produced fish are poorly understood, but likely to be negative (Flagg et al. 2001).

Hatchery programs may also have ecological effects that reduce the abundance and productivity of populations in the Upper Columbia Basin. NRC (1996) noted that 5.5 billion salmon smolts of all species are released to the wild each year around the Pacific Rim, with potential trophic effects that may lead to altered body size and survival of naturally produced fish. Emphasis on hatchery fish may also deny marine nutrients to infertile rearing streams used by relatively few naturally produced spring Chinook salmon and steelhead. Recent efforts, however, include the outplanting of hatchery carcasses in streams within the Upper Columbia Basin.

Because the Leavenworth and Entiat National Fish Hatcheries continue to release out-of-basin stocks of spring Chinook into their respective subbasins, these programs may be a threat to the diversity of locally derived spring Chinook in those systems. Tagging studies indicate that fish from the Leavenworth National Fish Hatchery generally have low stray rates (<1%) (Pastor 2004).[52] However, based on expanded carcass recoveries from spawning ground surveys (2001-2004), the Leavenworth National Fish Hatchery and other out-of-basin strays have comprised from 3-27% of the spawner composition upstream from Tumwater Canyon (WDFW, unpublished data). This stray information has contributed to the high-risk categorization of the Wenatchee population. Nonetheless, four years of data is not sufficient to evaluate the true spawner composition or its potential effects on the natural Wenatchee spring Chinook population.

Although state-operated artificial production programs emphasize use of locally derived stock for supplementation, they may also affect diversity and productivity of naturally produced stocks. For example, the supplementation programs may affect the age-at-return of spring Chinook, resulting in more younger-aged hatchery fish spawning in the wild (NMFS 2004). This could affect reproductive potential and ultimately productivity of naturally produced fish. The reproductive success of hatchery fish produced in supplementation programs that spawn naturally in the wild needs study. Additionally, straying of hatchery fish within and among populations can increase a population’s risk for genetic diversity. For example, risk increased because Wenatchee River steelhead strayed upstream of Rocky Reach Dam and Chiwawa River Hatchery spring Chinook comprised greater than 10% of the spawner composition in Nason Creek and the White and Little Wenatchee rivers in 2001 and 2002 (Tonseth 2003, 2004).

[52] It should be noted that prior to 1993, efforts to recover tags on spawning grounds varied.

Hatchery programs for steelhead occur in the Wenatchee, Methow, and Okanogan basins and are operated by WDFW, USFWS, and the Colville Tribes. These programs mitigate for habitat inundated by and juveniles killed at hydroelectric projects. Prior to 1997, most of the hatchery steelhead were of a co-mingled stock collected either at Priest Rapids or Wells dams. In 1997 WDFW began a program of Wenatchee steelhead with broodstock collected from the Wenatchee basin. The Methow and Okanogan basins continue to use broodstock collected at Wells Dam. The combined broodstock for the Methow and Okanogan basins and the high proportion of hatchery fish on the spawning grounds contributes to the high risk of the DPS.

Although there are currently no bull trout artificial propagation programs in the Upper Columbia Basin, the USFWS has determined that reaching a recovery condition in the Upper Columbia Basin within 25 years may require the use of artificial propagation. This may involve the transfer of bull trout into unoccupied habitat within the historic range. Artificial propagation may also involve the use of federal or state hatcheries to assist in recovery. Research is needed to evaluate the effectiveness and feasibility of using artificial propagation in bull trout recovery.

3.6 Hydropower

Spring Chinook and steelhead production areas in the pre-development period included the Wenatchee, Entiat, Methow, Okanogan, and limited portions of the Similkameen, Spokane, San Poil, Colville, Kettle, Pend Oreille, and Kootenay rivers.[53] Grand Coulee and Chief Joseph dams eliminated access to the Columbia River upstream of those projects. The GCFMP, designed to transfer populations formerly produced upstream into remaining habitat downstream from Grand Coulee, trapped fish at Rock Island in 1939-1943. Managers placed some adults in tributaries (e.g., Nason Creek) to spawn naturally, and artificially propagated others. Spring Chinook from outside the Upper Columbia Basin were introduced.[54] The construction of these dams and the GCFMP transfigured the abundance, spatial structure, and diversity of spring Chinook and steelhead populations in the Upper Columbia Basin (Chapman et al. 1995).

The era of mainstem multi-purpose dams downstream from the Grand Coulee project began with Rock Island Dam in 1933 and culminated with completion of Wells Dam and John Day Dam in 1967 and 1968, respectively. Seven mainstem dams lie between the Wenatchee River and the sea, eight downstream from the Entiat River, and nine between the Methow/Okanogan systems and the estuary. Adult salmon and steelhead losses at each project could be as high as 4% or more in some years (Chapman et al. 1994 and 1995), and juvenile losses at each project can amount to approximately 5-10%.[55] Some of the losses result from physical effects of adult and juvenile/smolt passage. Others derive from altered limnological conditions that increase predation by fish and birds. Whatever the direct causes, losses for Wenatchee adults and

[53] Natural falls blocked salmon and steelhead access to some areas of the Spokane, Colville, Kettle, Pend Oreille, Similkameen, and Kootenay rivers.
[54] Spring Chinook from outside the Upper Columbia Basin were introduced because disease eliminated the original stock from being propagated. The fish introduced were a mixture of Upper Columbia and Snake River spring Chinook (Pastor 2004).
[55] Estimates of smolt mortality (per project and cumulative) rely more on PIT tag and acoustic tag survival studies for yearling Chinook and steelhead in the Upper Columbia Basin. Chapman et al. (1995) discussed uncertainties associated with inter-dam conversion rates for adults and mortality associated with dam passage cannot be separated from natural mortality.

juveniles could accumulate to an estimated 25% and 52%, respectively. For Methow River fish, which must pass two additional dams, losses may accumulate to an estimated 31% and 61% for adults and juveniles, respectively.[56] The cumulative loss rates also explain why so much mitigative effort has been allocated to hydroproject-related mortality rates.

Dams for storage, like Grand Coulee, and mainstem multipurpose dams have had other effects on the ecology of salmon and steelhead. Estuarine limnology has shifted from a basis of large organics and bottom invertebrates to small organics and planktonic organisms that favor non-salmonids (Chapman and Witty 1993). Spring freshet flows and turbidity have declined in the river and estuary, and the Columbia River plume has been reduced seasonally (Ebbesmeyer and Tangborn 1993; Chapman et al. 1994 and 1995; NRC 1996) with potential but largely unknown effects on survival of salmon and steelhead in the estuary and nearshore ocean.

The effects of dams on bull trout in the Upper Columbia Basin are less well understood. Dams on the mainstem Columbia River and tributaries have modified stream flows and temperature regimes, altered productivity, changed habitat quantity and quality, and blocked migration corridors. These changes probably affected the abundance and spatial structure of bull trout in the Upper Columbia Basin (Bull Trout Draft Recovery Plan 2002). However, recent research suggests that the increased trophic productivity of Columbia River reservoirs may benefit bull trout, because bull trout rearing in the reservoirs grow faster and larger there than do bull trout that remain in tributaries (BioAnalysts 2003). Recent and ongoing telemetry studies in the Upper Columbia Basin also indicate that adult bull trout move through the dams and arrive on spawning grounds within their spawning windows (BioAnalysts 2003). On the other hand, the effects of dams on juvenile bull trout movement and survival are unknown.

3.7 Habitat

Various land-use activities and management practices in concert with natural events may have affected the habitat used by Chinook salmon, steelhead, and bull trout in the Upper Columbia Basin. Activities within the Upper Columbia Basin that may have affected habitat conditions include diversions and dams, agricultural activities, stream channelization and diking, roads and railways, timber harvest, and urban and rural development (Mullan et al. 1992; Chapman et al. 1994, 1995; UCRTT 2003; Subbasin Plans 2004, 2005).

Limiting factors may not be fully understood within each subbasin. This plan relies on monitoring and adaptive management to assist in the identification of limiting factors and to assess effects of habitat actions. As such, the limiting factors identified in this plan can be considered working hypotheses, which can be tested to better understand the factors and associated threats that currently limit ESA-listed species in the Upper Columbia Basin (see Section 8.2).

Some of the factors that affected the habitat of the three species historically have been partially addressed through changes in land-use practices (e.g., diversions, fish screens, riparian buffer

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[56] Whether the loss rates per project are slightly higher or lower than shown, the cumulative loss rates provide an impression of the importance, relative to other factors, of mainstem dams as a factor for decline. The pre-dam loss rates for adults and smolts that pass through each project reach are unknown, but unlikely to have reached post-dam levels in most years.

strips, improved livestock management, etc.). However, as noted in the subbasin plans and watershed plans, there are activities that continue to affect the habitat of Chinook salmon, steelhead, and bull trout in the Upper Columbia Basin. Identified in Section 5.5.2 are limiting factors and their assumed causal mechanisms (threats) that affect habitat conditions for spring Chinook, steelhead, and bull trout in each subbasin. Within each subbasin (population or core area), the limiting habitat factors and causal agents are identified by assessment unit. Limiting factors and threats were derived from watershed plans, subbasin plans, EDT analysis, and the biological strategy prepared by the Upper Columbia Regional Technical Team (UCRTT 2003).

3.8 Ecological Factors

The biotic communities of aquatic systems in the Upper Columbia Basin are highly complex. Within aquatic communities, assemblages and species have varying levels of interaction with one another. Direct interactions may occur in the form of predator-prey, competitor, and disease- or parasite-host relationships. In addition, many indirect interactions may occur between species. For example, predation of one species upon another may enhance the ability of a third species to persist in the community by releasing it from predatory or competitive constraints (e.g., Mittelbach 1986; Hillman et al. 1989a). These interactions continually change in response to shifting environmental and biotic conditions. Human activities and management decisions that change the environment, the frequency and intensity of disturbance, or species composition can shift the competitive balance among species, alter predatory interactions, and change disease susceptibility. All of these changes may result in community reorganization and a reduction in Chinook, steelhead, and bull trout abundance and spatial structure. The overall effect of ecological factors on population viability is mostly unknown.

3.8.1 Competition

Competition among organisms occurs when two or more individuals use the same resources and when availability of those resources is limited (Pianka 2000). That is, for competition to occur, demand for food or space must be greater than supply (implies high recruitment or that the habitat is fully seeded) and environmental stresses few and predictable. Two types of competition are generally recognized: (1) interference competition, where one organism directly prevents another from using a resource through aggressive behavior, and (2) exploitation competition, where one species affects another by using a resource more efficiently. Salmonids likely compete for food and space both within species (intraspecific) and between species (interspecific). Interspecific interactions are more likely to occur between native and exotic species, rather than between species that coevolved together (Reeves et al. 1987; Hillman 1991).

Exotic species are more likely to interact with spring Chinook, steelhead, and bull trout because exotics have not had time to segregate spatially or temporally in their resource use. For example, there is a possibility that brook trout interact with spring Chinook, steelhead, and bull trout in the upper basin. Welsh (1994) found no evidence that brook trout displaced Chinook salmon. On the other hand, Cunjak and Green (1986) found that brook trout were superior competitors to rainbow/steelhead at colder temperatures (9°C), while rainbow/steelhead were superior at warmer temperatures (16°C). Brook trout are important competitors with bull trout (Dambacker et al. 1992; Nakano et al. 1998). Goetz (1989) reported that where brook trout and bull trout occur together, bull trout populations have declined.

Although coho salmon were native to the upper basin, they have been absent for many decades. Recently, there have been efforts to re-establish them in the Upper Columbia Basin (Murdoch et al. 2002). Because there is uncertainty about the positive or negative effects of the reintroduction program, studies are underway to evaluate the potential effects of the program on listed species.

A potentially important source of exploitative competition occurring outside the geographic boundary of the ESU and the DPS may be between the exotic American shad (***Alosa sapidissima***) and juvenile Chinook and steelhead. Palmisano et al. (1993a, 1993b) concluded that increased numbers of shad likely compete with juvenile salmon and steelhead, resulting in reduced abundance and production of salmon and steelhead.

3.8.2 Predation

Fish, mammals, and birds are the primary natural predators of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Although the behavior of spring Chinook, steelhead, and bull trout precludes any single predator from focusing exclusively on them, predation by certain species can nonetheless be seasonally and locally important. Changes in predator and prey populations along with major changes in the environment, both related and unrelated to development and management decisions in the Upper Columbia Basin, have reshaped the role of predation (Mullan et al. 1986; Li et al. 1987).

Although several fish species consume spring Chinook, steelhead, and bull trout in the Upper Columbia Basin, northern pikeminnow, walleyes, and smallmouth bass have the potential to negatively affect the abundance of juvenile salmonids (Gray and Rondorf 1986; Bennett 1991; Poe et al. 1994; Burley and Poe 1994). These are large, opportunistic predators that feed on a variety of prey and switch their feeding patterns when spatially or temporally segregated from a commonly consumed prey. Channel catfish have the potential to significantly affect the abundance of juvenile salmonids (see e.g., Gray and Rondorf 1986; Poe et al. 1994), but because they are rare in the Upper Columbia (Dell et al. 1975; Burley and Poe 1994), they probably have a small effect on survival of juvenile spring Chinook, steelhead, and bull trout there. Native species such as sculpins and white sturgeon also prey on juvenile salmonids (Hunter 1959; Patten 1962, 1971a, 1971b; Mullan 1980; Hillman 1989). Sculpins eat large numbers of juvenile Chinook and steelhead in tributaries (Hillman 1989).

Most adult salmonids within the Upper Columbia Basin are opportunistic feeders and are therefore capable of preying on juvenile spring Chinook, steelhead, and bull trout. Those likely to have some affect on the survival of juvenile salmonids include adult bull trout, rainbow/steelhead trout, cutthroat trout, brook trout, and brown trout. Of these, bull trout and rainbow trout are probably the most important; however, cutthroat trout are also known to prey on other salmonids.[57] These species occur together with juvenile spring Chinook, steelhead, and

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[57] The recovery of ESA-listed species that prey on other ESA-listed species (e.g., bull trout that prey on juvenile spring Chinook and steelhead) may appear to be counterproductive. However, the recovery levels established in this plan for bull trout will not prevent the recovery of the other listed species. The three ESA-listed species evolved together in the Columbia Basin and their niches are sufficiently segregated to prevent one species from driving the others to extinction. Large bull trout are generalists and will not prey exclusively on spring Chinook and steelhead.

bull trout in most tributaries; hence the probability for interaction is high. The presence of migrant stocks of bull trout in the region further increases the likelihood for interaction there.

Predation by piscivorous birds on juvenile salmonids may represent a large source of mortality. Fish-eating birds that occur in the Upper Columbia Basin include great blue herons (***Ardea herodias***), gulls (***Larus*** spp.), osprey (***Pandion haliaetus***), common mergansers (***Mergus merganser***), American dippers (***Cinclus mexicanus***), cormorants (P***halacrocorax*** spp.), Caspian terns (***Sterna caspia***), belted kingfishers (***Ceryle alcyon***), common loons (***Gavia immer***), western grebes (***Aechmophorus occidentalis***), black-crowned night herons (***Nycticorax nycticorax***), and bald eagles (***Haliaeetus leucocephalus***) (T. West, Chelan PUD, personal communication). These birds have high metabolic rates and require large quantities of food relative to their body size. In the Columbia River estuary, avian predators consumed an estimated 16.7 million smolts (range, 10-28.3 million smolts), or 18% (range, 11-30%) of the smolts reaching the estuary in 1998 (Collis et al. 2000). Caspian terns consumed primarily salmonids (74% of diet mass), followed by double-crested cormorants (***P. auritus***) (21% of diet mass) and gulls (8% of diet mass). The NMFS (2000) identified these species as the most important avian predators in the Columbia River basin.

Mammals may be an important agent of mortality to spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Predators such as river otters (***Lutra Canadensis***), raccoons (***Procyon lotor***), mink (***Mustela vison***), and black bears (***Ursus americanus***) are present in the Upper Columbia Basin. These animals, especially river otters, are capable of removing large numbers of salmon and trout (Dolloff 1993). Black bears consume large numbers of salmon (and bull trout),[58] but generally scavenge post-spawned salmon. Pinnipeds, including harbor seals (***Phoca vitulina***), California sea lions (***Zalophus californianus***), and Stellar sea lions (***Eumetopia jubatus***) are the primary marine mammals preying on Chinook and steelhead originating from the Upper Columbia basin (Spence et al. 1996). Pacific striped dolphin (***Lagenorhynchus obliquidens***) and killer whale (***Orcinus orca***) may also prey on adult Chinook and steelhead. Seal and sea lion predation is primarily in saltwater and estuarine environments though they are known to travel well into freshwater after migrating fish. All of these predators are opportunists, searching out locations where juveniles and adults are most vulnerable. These species have always interacted to some degree.

The UCSRB supports immediate adoption of more effective predator control programs, including lethal removal when necessary, of the marine and avian predators that have the most significant negative impacts on returns of Upper Columbia Basin ESA-listed salmonid fish stocks.

3.8.3 Disease and Parasitism

Spring Chinook, steelhead, and bull trout can be infected by a variety of bacterial, viral, fungal, and microparasitic pathogens. Numerous diseases may result from pathogens that occur naturally in the wild or that may be transmitted to naturally produced fish via infected hatchery fish. In most cases, environmental stress (such as unsuitable temperatures) reduces the resistance of fish

[58] Evidence of bears preying on bull trout has been noted several times in Nason and Rock creeks in the Wenatchee subbasin.

to disease. Among the infections are bacterial diseases, including bacterial kidney disease (BKD), columnaris, furunculosis, redmouth disease, and coldwater disease; virally induced diseases, including infectious hepatopoietic necrosis (IHN), infectious pancreatic necrosis (IPNV), and erythrocytic inclusion body syndrome (EIBS); protozoan-caused diseases, including ceratomyxosis and dermocystidium; and fungal infections, such as saprolegnia (Bevan et al. 1994). One theory is that disease may have contributed to the loss of bull trout in the Lake Chelan subbasin (Brown 1984). Numerous bull trout covered with fungus (a secondary infection)[59] were found dead along the shoreline shortly before the last bull trout were observed in the subbasin.

Chinook in the Columbia River have a high incidence of BKD (Chapman et al. 1995). Incidence appears higher in spring Chinook (Fryer 1984) and can be a major problem in hatchery-reared Chinook throughout the Columbia Basin (Chapman et al. 1995). Viral infections such as IPNV have been detected in hatchery steelhead in the Upper Columbia region (Chapman et al. 1994).

Sublethal chronic infections can impair the performance of Chinook, steelhead, and bull trout in the wild, thereby contributing secondarily to mortality or reduced reproductive success. Fish weakened by disease are more sensitive to other environmental stresses. Additionally, they may become more vulnerable to predation (Hoffman and Bauer 1971), or less able to compete with other species. For example, both Hillman (1991) and Reeves et al. (1987) found that water temperature affected interactions between redside shiners and the focal species. Both researchers noted that outcomes of interactions were, in part, related to infection with ***F. columnaris***. In their studies, most Chinook and steelhead were infected at warmer temperatures, whereas shiners showed a higher incidence of infection at cooler temperatures.

3.9 Factors outside the ESU and DPS

The most comprehensive and instructive index of spring Chinook and steelhead survival beyond the boundary of the ESU and the DPS (downstream from the mouth of the Yakima River) is smolt-to-adult return rate (SAR). It is a common survival index used to characterize the performance of salmonid populations throughout the Pacific Northwest. This survival index reflects all agents of mortality affecting the life cycle of salmon and steelhead from migrating smolts through returning adults. Various sources of mortality acting on populations during this portion of their life cycle include:[60]

- Hydrosystem operations
- Migration conditions in the mainstem, including both natural and man-made causes (e.g., actions associated with urbanization and industrialization) and their effects on water quality (e.g., total dissolved gases and temperature)
- Fish condition, which can vary annually by hatchery or rearing stream
- Marine/estuarine conditions and processes influenced by natural and man-made factors

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[59] Fungus is a secondary infection. The primary cause could have been an infectious agent, a toxic substance, or some other factor (USFWS 1990).

[60] An estimate of the relative effect of each factor on SAR cannot be calculated at this time.

- Harvest in marine and riverine waters
- Predation

Changes in ocean conditions can have large effects on SARs. For example, adult returns during the period 1980-1999, during periods of poor ocean conditions, were much lower than those during better ocean conditions (2000-2004). In the QAR assessment, results for Upper Columbia spring Chinook showed the survival improvement required to avoid the risk of extinction criteria was either 95, 47, or 2% depending on whether a historical time period back to 1980, 1970, or 1960 (a period of better ocean conditions) was used, respectively. If one were to add recent years (2000-2004, representing better ocean conditions) to the analysis, estimated required survival increases would decrease by about one third or more. Recovery will require sufficient abundance and productivity to withstand the periods of poor ocean conditions.

SARs can be calculated in different ways. Juvenile salmonids implanted with either passive integrated transponder (PIT) tags or coded wire tags (CWT) can be used to estimate SAR, if returning adults can be sampled at strategic locations. Alternatively, the survival index can be calculated by estimating smolt abundance passing some site (e.g., a dam or the mouth of a tributary), then subsequently estimating adult returns to that location for a specific brood year. Often, SARs are expressed in terms of return rates to the mouth of the Columbia River. This calculation requires additional information such as estimates of in-river harvest and adult passage mortality. SARs expressed in terms of return rates to the mouth of the Columbia River are less useful when evaluating viability, because viability is based on how many fish reach the spawning grounds, not the Columbia River mouth.

3.9.1 Spring Chinook

Historical estimates of SARs for naturally produced spring Chinook in the Upper Columbia Basin have been reported by Mullan et al. (1992) and Raymond (1988). Mullan et al. (1992) estimated smolt-to-adult return rates for the collective populations produced in the Wenatchee, Entiat, and Methow rivers for the years 1967 -1987. Over that period, SARs ranged from 2.0 to 10.1%. These estimates reflected corrections for adult passage mortality as well as marine and in-river harvest. Therefore, these rates overestimate the survival of adults back to the spawning grounds.

Raymond (1988) estimated percent returning hatchery and naturally produced adults to Priest Rapids Dam for the years 1962 through 1984. Values for naturally produced and hatchery spring Chinook ranged from 0.3 to 4.9% and 0.1 to 4.5%, respectively, over those years. One reason Raymond's values were generally lower than those reported by Mullan et al. (1992) may be that his estimates were not adjusted for adult passage mortality and marine harvest, whereas Mullan's were. Also, the reference locations for calculating SARs differed, with Raymond focusing on dam counts and the other investigators referencing the spawning grounds. Therefore, Raymond's estimates of SAR would also overestimate the survival of adults back to the spawning grounds.

WDFW (unpublished data) recently calculated an eight-year (1993-2000) geometric mean SAR for naturally produced spring Chinook from the Chiwawa River, a watershed in the Wenatchee Subbasin. They estimated numbers of smolts from a trap located near the mouth of the Chiwawa River. They calculated adults using broodstock, tributary spawning escapement, and harvest estimates. They derived spawning escapement estimates from total ground redd counts, expanded by the male to female ratio of broodstock collected from the Chiwawa Weir. They estimated harvest rates by using a surrogate stock (spring Chinook from the Leavenworth National Fish Hatchery), which have a probability of harvest similar to naturally produced Chiwawa stock. WDFW estimated an eight-year geometric mean SAR of 0.63 (standard deviation of ±0.63). Unlike other SARs, this estimate reflects survival of adults back to the spawning grounds, which provides the most relevant assessment of viability.

3.9.2 Steelhead

Raymond (1988) estimated smolt-to-adult return percentages for the combined naturally produced and hatchery steelhead population, 1962-1984. Adult return rates to Priest Rapids Dam ranged from a low of 0.2% for the smolt migration of 1977 to a high of 6.4% for the 1982 smolt migration. Mullan et al. (1992) reported SARs for only one stock, Well Hatchery steelhead, during the period 1982-1987. The percent return to the mouth of the Columbia River averaged 6.38%, ranging from 1.32 to 14.28%. Survival back to Wells Dam averaged 3.01% and ranged from 0.72 to 7.31%. These estimates aligned closely with Raymond's estimates for the overlapping years 1982-1984. Chapman et al. (1994) compiled data from three hatcheries in the Upper Columbia (Chelan, Entiat, and Leavenworth) for the years 1961-1991. Smolt-to-adult survival averaged 1.7%, with a range from 0.16-7.54%.

3.10 Interaction of Factors

As noted above, a wide range of factors have affected the abundance, productivity, spatial structure, and diversity of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. What is less clear is how different factors have interacted to depress populations within the Upper Columbia Basin.

Presently, harvest has been greatly reduced from historic levels, dams are addressing ways to increase passage and reservoir survival, hatcheries are addressing spatial structure and diversity issues, and habitat degradation is being reduced by implementation of recovery projects, voluntary projects, voluntary efforts of private landowners, improved land management practices on public and private lands, and changing regulations. Nevertheless, additional actions must be taken within all the Hs in order for listed stocks in the Upper Columbia Basin to recover. Actions taken within one or two Hs will not recover listed populations. For example, hatcheries can only be effective to sustain a fishery if habitat also remains in good condition. In the same way, changes only within the hydropower system will not in itself lead to recovery. Because all the Hs, and their interactions, affect the viability of listed populations in the Upper Columbia Basin, actions implemented within all Hs are needed to recover the populations.

Populations within the Upper Columbia River Basin were first affected by the intensive commercial fisheries in the lower Columbia River. These fisheries began in the latter half of the 1800s and continued into the 1900s and nearly extirpated many salmon and steelhead stocks. These fisheries largely affected the abundance, productivity, and diversity of stocks in the Upper Columbia Basin. With time, the construction of dams and diversions, some without passage, blocked salmon and steelhead migrations, fragmented bull trout populations, and killed upstream and downstream migrating fish. Dams and diversions reduced the abundance and productivity of stocks, but also affected their spatial structure by blocking historic spawning and rearing areas. Early hatcheries constructed to mitigate for fish loss at dams and loss of spawning and rearing habitat were operated without a clear understanding of population genetics, where fish were transferred without consideration of their actual origin. Although hatcheries were increasing the number of natural spawners, they also decreased the diversity and productivity of populations they intended to supplement.

Concurrent with these activities, human population growth within the basin was increasing and numerous land uses (agriculture, mining, timber harvest, transportation systems, and urban and rural development), in many cases encouraged and supported by governmental policy, were degrading and polluting salmon and trout spawning and rearing habitat. In addition, exotic (non-native) species were introduced by both public and private interests throughout the region that directly or indirectly affected salmon and trout. All these activities (harvest, hydropower, hatcheries, and habitat) acting in concert with natural disturbances (e.g., drought, floods, landslides, fires, debris flows, and ocean cycles) have decreased the abundance, productivity, spatial structure, and diversity of Chinook salmon, steelhead, and bull trout in the Upper Columbia Basin.

One way to assess the effects of different Hs and their interactions is to integrate smolts/redd estimates (measure of tributary productivity) and SARs (measure of factors outside the subbasin) and examine the interaction of the two factors on population viability. WDFW (unpublished data) calculated smolts/redd and SARs for naturally produced spring Chinook in the Wenatchee subbasin. These data suggest that at current smolts/redd estimates for the Wenatchee subbasin, SARs need to be higher than 1% to reach a population growth rate of 1.0 (returns/spawner) (**Figure 3.1**). Lower SARs (1.0%) result in population growth rates of 1.0 if tributary habitat is capable of producing more than 300 smolts/redd. However, at the high spawner abundances needed for recovery, juvenile productivity (smolts/redd) is expected to decrease because of density-dependent effects (**Figure 3.2**). The available data suggest that the pristine habitat of the Chiwawa River can only produce 200-300 smolts/redds at the abundances that will be required to meet adult spawner targets for recovery (**Figure 3.2**).[61] During periods of poor ocean conditions, tributary productivity will need to be sufficiently high to maintain a population growth rate of 1.0. Currently, these estimates are only available for spring Chinook in the Wenatchee subbasin. Similar data are needed from other populations within the Upper Columbia Basin. Further development of this analysis and application to other populations is needed to assess the contribution of tributary actions to recovery.

3.11 Current Threats

The previous sections identified factors that led to the decline of Upper Columbia spring Chinook, steelhead, and bull trout. In this section the plan summarizes current threats to the continued existence of the three species. These threats are organized according to the five categories as set forth in Section 4(a)(1) of the ESA and all apply to this recovery plan:

- The present or threatened destruction, modification, or curtailment of its habitat or range.
- Overutilization for commercial, recreational, scientific, or educational purposes.
- Disease or predation.

[61] These data must be used cautiously. They currently lack a sufficient number of productivity estimates at high spawner abundances.

- Inadequacy of existing regulatory mechanisms.
- Other natural or human-made factors affecting its continued existence.
- The information outlined in this section comes from the Federal Register Rules and Regulations, watershed plans, and subbasin plans.

3.11.1 Spring Chinook

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture (including livestock grazing), residential development, and historic forest management continue to threaten spring Chinook and their habitat in some locations in the Upper Columbia Basin.
- Water diversions without proper passage routes disrupt migrations of adult spring Chinook.
- Unscreened diversions trap or divert juvenile spring Chinook resulting in reduced survival.
- Hydroelectric passage mortality reduces abundance of migrant spring Chinook.
- Sedimentation from land and water management activities is a cause of habitat degradation in some salmon streams.
- Loss of habitat complexity, off-channel habitat, and large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large woody debris threatens spring Chinook and their habitat in some locations in the Upper Columbia Basin.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- The effects of recreational fishing on naturally produced spring Chinook may be heightened during fisheries for hatchery produced Chinook.
- Incidental harvest mortality in mixed-stock fisheries and commercial fisheries contributes to the loss of naturally produced spring Chinook.
- Illegal harvest (poaching) continues to threaten spring Chinook.

Disease or Predation

- The presence of non-native (exotic) species (e.g., walleye and smallmouth bass) has resulted in increased predator populations that prey on spring Chinook.
- Increased predation by northern pikeminnow affects the survival of downstream migrating spring Chinook.
- Avian predation is a threat to spring Chinook populations.
- Predation by pinnipeds is also a concern.

Inadequacy of Existing Regulatory Mechanisms[62]

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.
- Although the Washington State Growth Management Act (GMA) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.
- The extent and distribution of Federal lands limits the ability of the Northwest Forest Plan and PACFISH/INFISH to achieve its aquatic habitat restoration objectives at watershed and river basin scales.
- The "base" State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of spring Chinook.
- Implementation of the Federal Clean Water Act has not been completely successful in protecting spring Chinook, particularly with respect to non-point sources of pollution.

Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.)[63] can exacerbate the problems associated with degraded and altered riverine and estuarine habitats.
- Drought conditions reduce already limited spawning, rearing, and migration habitat.
- Poor ocean conditions (e.g., less upwelling, warm surface waters, etc.) negatively affect spring Chinook production.
- The use of non-locally derived broodstock for hatchery programs may negatively affect genetic integrity.
- The collection of naturally produced spring Chinook for hatchery broodstock may harm small or dwindling natural populations if not done with caution.
- Competition, genetic introgression, and disease transmission resulting from hatchery introductions may reduce the productivity and survival of naturally produced spring Chinook.

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[62] The UCSRB believes innovative and outcome based land-use planning and management techniques will be more effective in improving habitat conditions than increasing restrictive and prescriptive regulations.

[63] Natural disturbance is not necessarily a bad thing. Indeed, species richness and diversity are higher in areas with some disturbance ("Intermediate Disturbance Hypothesis"; Connell 1978). However, when disturbances occur too often (resulting from the cumulative effects of both natural and un-natural disturbances), species richness and diversity decrease because some species go extinct.

3.11.2 Steelhead

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture (including livestock grazing), residential development, and historic forest management continue to threaten steelhead and their habitat in some locations in the Upper Columbia Basin.
- Water diversions without proper passage routes disrupt migrations of adult steelhead.
- Unscreened diversions trap or divert juvenile steelhead resulting in reduced survival.
- Hydroelectric passage mortality reduces abundance of migrant steelhead.
- Sedimentation from land and water management activities is a cause of habitat degradation in some streams.
- Loss of habitat complexity, off-channel habitat, and large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large woody debris threatens steelhead and their habitat in some locations in the Upper Columbia Basin.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- The effects of recreational fishing on naturally produced steelhead may be heightened during fisheries for hatchery-produced steelhead.
- Incidental harvest mortality in mixed-stock fisheries and commercial fisheries contributes to the loss of naturally produced steelhead.
- Illegal harvest (poaching) continues to threaten steelhead.

Disease or Predation

- The presence of non-native species (e.g., walleye and smallmouth bass) has resulted in increased predator populations that prey on steelhead.
- Increased predation by northern pikeminnow affects the survival of downstream migrating steelhead.
- Avian predation is a threat to steelhead populations.
- Predation by pinnipeds is also a concern.

Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.
- Although the Washington State Growth Management Act (GMS) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and

protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.

- The extent and distribution of Federal lands limits the ability of the Northwest Forest Plan and PACFISH/INFISH to achieve its aquatic habitat restoration objectives at watershed and river basin scales.
- The "base" State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of steelhead.
- Implementation of the Federal Clean Water Act has not been completely successful in protecting steelhead, particularly with respect to non-point sources of pollution.

Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.) can exacerbate the problems associated with degraded and altered riverine and estuarine habitats.
- Drought conditions reduce already limited spawning, rearing, and migration habitat.
- Poor ocean conditions (e.g., less upwelling, warm surface waters, etc.) negatively affect steelhead production.
- The use of non-locally derived broodstock for hatchery programs may negatively affect genetic integrity.
- The collection of naturally produced steelhead for hatchery broodstock may harm small or dwindling natural populations if not done with caution.
- Competition, genetic introgression, and disease transmission resulting from hatchery introductions may reduce the productivity and survival of naturally produced steelhead.

3.11.3 Bull Trout

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

- Although land and water management activities have improved, factors such as dams, diversions, roads and railways, agriculture (including livestock grazing), residential development, and historic forest management continue to threaten bull trout and their habitat in some locations in the Upper Columbia Basin.
- Water diversions without proper passage routes disrupt movements of migrant bull trout.
- Unscreened diversions trap or divert juvenile bull trout resulting in reduced survival.
- Passage through hydroelectric projects may reduces abundance of migrant bull trout.
- Sedimentation from land and water management activities is a cause of habitat degradation in some bull trout streams.

- Loss of habitat complexity, connectivity, channel stability, decreased in-stream flow, and increased water temperatures due to land and water management activities threatens bull trout in some locations in the Upper Columbia Basin.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

- Illegal and incidental harvest (e.g., during the Lake Wenatchee sockeye fishery) reduces the abundance of bull trout in the Upper Columbia Basin.
- Harvest as a result of misidentification continues under existing fishing regulations.
- Poaching continues and can be especially detrimental to small, isolated, local populations of migratory bull trout.

Disease or Predation

- The presence of non-native species (e.g., brook trout, bass, lake trout, etc.) has resulted in increased predator populations that prey on juvenile bull trout.

Inadequacy of Existing Regulatory Mechanisms

- The implementation and enforcement of existing Federal and State laws designed to conserve fishery resources, maintain water quality, and protect aquatic habitat have not been entirely successful in preventing past and ongoing habitat degradation.
- Although the Washington State Growth Management Act (GMS) and Shoreline Management Act (SMA) have been significantly changed to improve management, conditions and protection efforts for listed species, local regulatory improvements, and compliance monitoring (enforcement) have lagged behind because of political support and a lack of funding.
- The extent and distribution of Federal lands limits the ability of the Northwest Forest Plan and PACFISH/INFISH to achieve its aquatic habitat restoration objectives at watershed and river basin scales.
- The "base" State of Washington Forest Practice Rules do not adequately address large woody debris recruitment, tree retention to maintain stream bank integrity and channel networks within floodplains, and chronic and episodic inputs of coarse and fine sediment that maintain habitat that are properly functioning for all life stages of bull trout.
- Implementation of the Federal Clean Water Act has not been completely successful in protecting bull trout, particularly with respect to non-point sources of pollution and water temperature.

Other Natural or Human-Made Factors Affecting its Continued Existence

- Natural climatic conditions (e.g., fires, floods, droughts, landslides, etc.) can exacerbate the problems associated with degraded and altered riverine habitat.
- Drought conditions can reduce already limited spawning, rearing, and migration habitat.

- Introduction of brook trout threatens bull trout through hybridization, competition, and predation.
- Introduction of non-native species for recreational fisheries may increase incidental catch and illegal harvest of bull trout.

As noted earlier, recent activities to address threats and reverse the long-term decline of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin are being initiated at Federal, State, and local levels (e.g., restrictive harvest regulations, adoption of various land management rules, and development of conservation strategies and plans). While these efforts are important to the conservation and recovery of ESA-listed species, additional work is needed to minimize threats to recovery (the subject of Section 5).

3.12 Uncertainties

The preceding sections described many of the important factors that have, and continue to, reduce the abundance, productivity, spatial structure, and diversity of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. It is clear that actions must be taken in all Hs (not just habitat) in order to recover listed populations. However, there are "key" areas of uncertainty[64] identified in Biological Opinions (BiOp), PATH (Plan for Analyzing and Testing Hypotheses), QAR analyses, USFWS Bull Trout Draft Recovery Plan, and Northwest Power and Conservation Council documents that can affect the success of actions implemented within each of the Hs. Resolution of uncertainties will greatly improve chances of attaining recovery goals outlined in this plan. These "key" uncertainties are highlighted below.

3.12.1 Ocean Productivity and Natural Variation

Global-scale processes in the ocean and atmosphere can regulate the productivity of marine, estuarine, and freshwater habitats of Chinook salmon and steelhead. Although managers cannot control these processes, natural variability must be understood to correctly interpret the response of salmon to management actions. For example, assessing needed survival improvements based on spawner returns from 1980-1999, during periods of below average climatic and other background conditions (Coronado and Hilborn 1998), has the effect of projecting these generally poor ocean conditions into the future. In the QAR assessment, results for Upper Columbia spring Chinook showed the survival improvement required to avoid the risk of extinction criteria was either 95, 47, or 2% depending on whether a historical time period back to 1980, 1970, or 1960 was used, respectively. If one were to add recent years (2000-2004, representing better ocean conditions) to the analysis, estimated required survival increases would decrease by about one third or more. Additional research is needed to help understand the mechanisms of ocean and climatic survival conditions, help improve forecasting and relating fisheries management capabilities, and help increase the likelihood that Upper Columbia populations persist over the full range of environmental conditions they are likely to encounter.

[64] Key uncertainties identify important gaps in our knowledge about the resources and functional relationships that determine fish viability.

3.12.2 Global Climate Change

The potential impacts of global climate change are recognized at national and international levels (Scott and Counts 1990; Beamish 1995; McGinn 2002). Many climate models project changes in regional snowpack and stream flows with global climate change. The effects of these changes could have significant effects on the success of recovery actions and the status of listed fish populations in the Upper Columbia Basin. The risks of global climate change are potentially great for Upper Columbia stocks because of the sensitivity of salmon stocks to climate-related shifts in the position of the sub-arctic boundary, the strength of the California Current, the intensity of coastal upwelling, and the frequency and intensity of El Nino events (NPCC 2004). Bull trout are particularly sensitive to water temperatures and it is uncertain how global climate change will affect their habitat. More research is needed to address the effects of climate change on ocean circulation patterns, freshwater habitat, and salmon and trout productivity.

3.12.3 Hatchery Effectiveness

Uncertainties exist regarding the potential for both benefits and harm of hatchery-produced fish on naturally spawning populations (see Section 5.3). A major uncertainty is whether it is possible to integrate natural and artificial production systems in the same subbasin to achieve sustainable long-term productivity. There is also uncertainty about the reproductive success of hatchery fish spawning in the wild. NOAA Fisheries evaluated survival requirements using a broad range of 20 to 80% historical effectiveness of hatchery-origin spawners to cover this uncertainty.[65] It is difficult to address the uncertainties and potential risks associated with hatcheries, because experimental methods for obtaining this information will take several years to get initial results and much longer before conclusions can be inferred from the empirical information. NOAA Fisheries and WDFW have initiated some of these studies in the Upper Columbia Basin and it is important that these experiments continue. Although supplementation is considered a potential benefit to recovery, it carries risks as noted here.

3.12.4 Density Independence

NOAA Fisheries analysis (2000 FCRPS BiOp) of needed survival improvements for spring Chinook and steelhead assumes that fish survival is independent of population density at all life stages. While density dependence is not apparent in single-stock models of population dynamics using only 1980-present data, PATH and others have found strong evidence of compensatory mortality (higher survival rates at lower population levels) and carrying capacity limits in Upper Columbia populations using data from the late 1950s to present. If the survival rates of Upper Columbia populations are density dependent at certain life stages (i.e., egg-to-smolt survival), then the analysis would tend to be pessimistic about extinction risks and optimistic with regard to survival increases necessary to achieve recovery levels. Incorporating density dependence would therefore tend to support lower risk for management actions that may not have immediate survival benefits, but require higher overall survival improvements to meet longer-term recovery goals. WDFW and the ICBTRT are currently drafting an approach for measuring tributary habitat performance that includes an evaluation of tributary density-dependence. They have

[65] This plan used 0-100% effectiveness of hatchery-produced spawners in steelhead run reconstructions (see Appendix C).

identified density-dependence in smolt production for Wenatchee spring Chinook (**Figure 3.2**). Additional research on density dependence (independence) is needed to provide a better understanding of the potential benefit of actions over time.

3.12.5 Differential Delayed Mortality of Transported Chinook and Steelhead (D Value)

The differential delayed mortality of transported spring Chinook and steelhead (D value) is the estimated ratio of the post-Bonneville survival of transported fish relative to in-river migrating fish. This differential mortality can occur during any time from release downstream from Bonneville Dam, through the estuary and ocean life stage, and during adult upriver migration to the specific dam from which they were transported. The factors determining D are complex and poorly understood. Little information is available on potential D values for Upper Columbia spring Chinook and steelhead. Historical data when fish were transported from McNary indicate a D ranging from 0.8 to 1.0. This uncertainty has little effect under current conditions because few Upper Columbia stocks are currently transported. However, an improved understanding of D will be necessary to determine the appropriate role of McNary transportation in the future. Furthermore, the future role of transportation and the potential benefit of major hydro-system configurations are highly sensitive to this uncertainty.

3.12.6 Invasive Species

Another critical uncertainty is the effect of invasive species on the viability of listed populations in the Upper Columbia Basin. One such species, American shad, may affect the abundance and survival of spring Chinook and steelhead in the lower Columbia River. It is possible that the growing population of shad is competing directly with juvenile Chinook and steelhead by cropping food sources important to salmonids in the lower Columbia River. It is also possible that the large numbers of shad in the lower river contribute to the growth of northern pikeminnow, smallmouth bass, and walleye, which are important predators of salmon and steelhead. Shad may be sustaining large populations of predators during periods when salmon and steelhead are not available to the predators, and, as a result, more and larger predators are present during periods when salmon and steelhead are moving through the lower Columbia River.

Brook trout is an invasive species within the Upper Columbia Basin that competes with bull trout for food and space. Brook trout can hybridize with bull trout and adult brook trout are known to feed on juvenile bull trout. Research is needed to assess the direct and indirect effects of invasive species (including invasive plants)[66] on the abundance and survival of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin.

[66] A short list of invasive plants include denseflower cordgrass, giant hogweed, Hydrilla, salt meadow cordgrass, Brazilian elodea, common cordgrass, Eurasian watermilfoil, fanwort, garden loosestrife, indigobush, parrotfeather, Japanese knotweed, perennial pepperweed, purple loosestrife, saltcedar, smooth cordgrass, wand loosestrife, water primrose, yellow floating heart, common reed, leafy spurge, curly-leaf pondweed, hairy whitetop, hoary cress, reed canarygrass, and yellow flag iris.

3.12.7 Independent Populations

ICBTRT and QAR identified independent spring Chinook and steelhead populations within the Upper Columbia Basin. QAR and PATH assessments assumed that spawning aggregations of an ESU or a DPS behaved as independent populations in isolation. Likewise, the Bull Trout Draft Recovery Plan (USFWS 2002) identified independent "core" bull trout populations, which are made up of several "local" populations. Given the geographic proximity and genetic similarity of many of these sub-groups, the assumption of independence is questionable and may lead to pessimistic assessments of needed survival improvements. Research regarding population structures, natural straying and movement among aggregations, and improvements to the assessment methods to include meta-population dynamics may be warranted. The monitoring program outlined in this plan and detailed in the Upper Columbia Monitoring Strategy (Hillman 2004), completed watershed plans, and subbasin plans will contribute substantially to resolving this uncertainty.

3.12.8 Effects of Dams on Bull Trout

The Bull Trout Draft Recovery Plan (USFWS 2002) has identified dams as an important factor for the decline of bull trout in the Upper Columbia Basin. Although it is true that dams can affect salmonids by delaying or impeding migration of adults and by injuring or killing juveniles that pass downstream, there is currently little information on the effects of dams on bull trout in the Upper Columbia River. Recent research by BioAnalysts (2002, 2003) indicates that adult bull trout passed through mainstem PUD dams with no loss and arrived on spawning grounds within their spawning window. In contrast, there is virtually no information on the effects of mainstem dams on juvenile (or subadult) bull trout. Additional work is needed to assess the effects of dams on the viability of bull trout in the Upper Columbia Basin.

Dams and other passage barriers in the Upper Columbia may affect bull trout. For example, in the Wenatchee River basin, Tumwater Dam, Dryden Dam, Dam 5 on Icicle Creek, and the weir on the Chiwawa River may affect bull trout spatial structure and diversity. Seasonal closure of adult passage facilities at the dams may adversely affect adult bull trout movement during certain times of year.

3.12.9 Interaction between Resident and Migrant Bull Trout Life-History Types

The Bull Trout Draft Recovery Plan (USFWS 2002) proposes recovery criteria for bull trout based on connectivity, abundance, productivity, and spatial structure of migrant (fluvial and adfluvial) life-history types. A critical uncertainty is the role of resident life-history types in maintaining viable populations of bull trout. Little is known about the abundance and spatial structure of resident forms in the Upper Columbia Basin, and even less is known about their contribution to migrant life-history types. Research is needed to assess the spatial structure and importance of resident types in maintaining viable populations of bull trout in the Upper Columbia Basin.

3.12.10 Effects of Harvest, Hatchery, Hydropower, and Habitat Actions

A critical uncertainty associated with the implementation of this recovery plan will be the effect of management actions or strategies on the environment and on life-stage specific survival rate and population level responses. It is unclear how strategies implemented within each of the Hs (Harvest, Hatcheries, Hydropower, and Habitat) will interact and contribute to recovery. In particular, a high level of uncertainty exists for the magnitude and response time of habitat actions. Even if all habitat actions could be implemented immediately (which they cannot), there will be delays in the response to actions. Populations will likely respond more quickly to some actions (e.g., diversion screens and barrier removals) than they will to others (e.g., riparian plantings). Although the effects of interacting strategies on population VSP parameters remain unknown, monitoring will contribute substantially to resolving this uncertainty.

3.12.11 Effects of Human Population Growth

Human population growth in the Upper Columbia Basin and its effects on recovery of listed species is a critical uncertainty. The size of the human population within the Upper Columbia region is expected to nearly double in the next two decades (may not apply equally across all subbasins).[67] Projected development will probably expand along streams and rivers at a greater rate than in upland areas. At the time this plan was written, critical area ordinances and comprehensive plans are being updated. A high degree of coordination among agencies, tribes, and counties will be needed to maximize recovery efforts.

[67] See http://www.ofm.wa.gov/pop/gma/

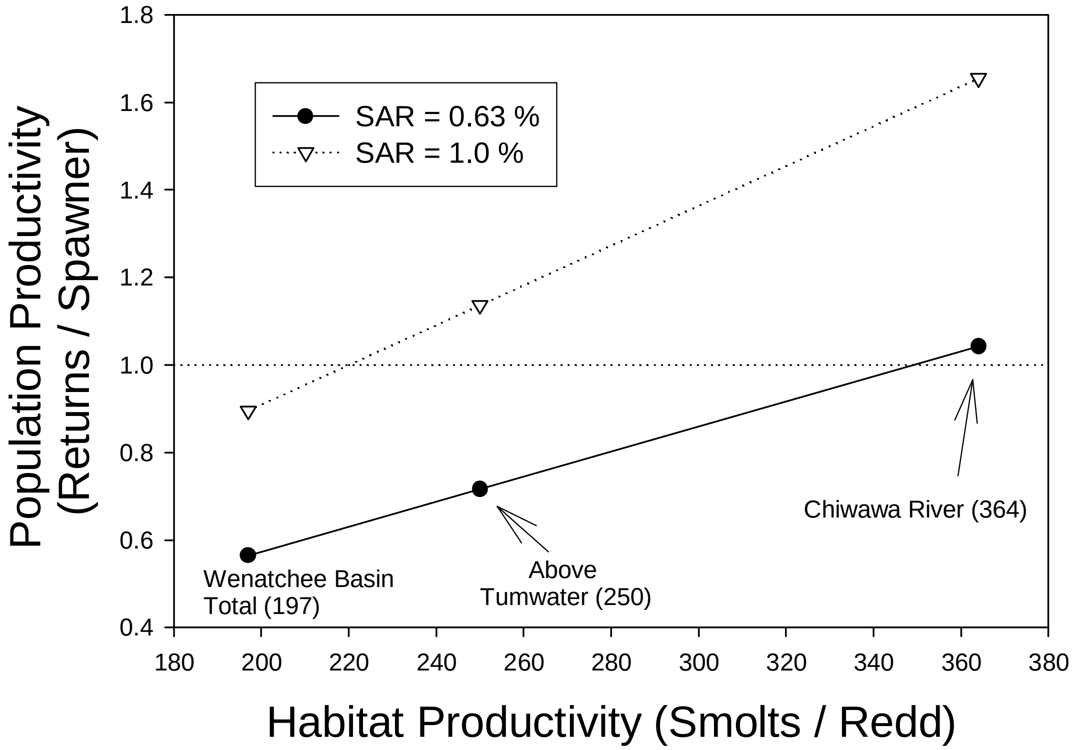

Figure 3.1 Returns per spawner for three levels of productivity (average smolts/redd) and smolt-to-adult return rates (SAR) for spring Chinook in the Wenatchee River, Washington. The SAR of 0.63% was the 8-yr geometric mean from 1993-2000 for naturally produced Chiwawa River spring Chinook (WDFW, unpublished data). The 1% SAR was modeled at the same productivity values for a theoretical comparison. This simple arithmetic model does not account for variance, autocorrelation, or density dependence and should not be used to determine targets for either metric.

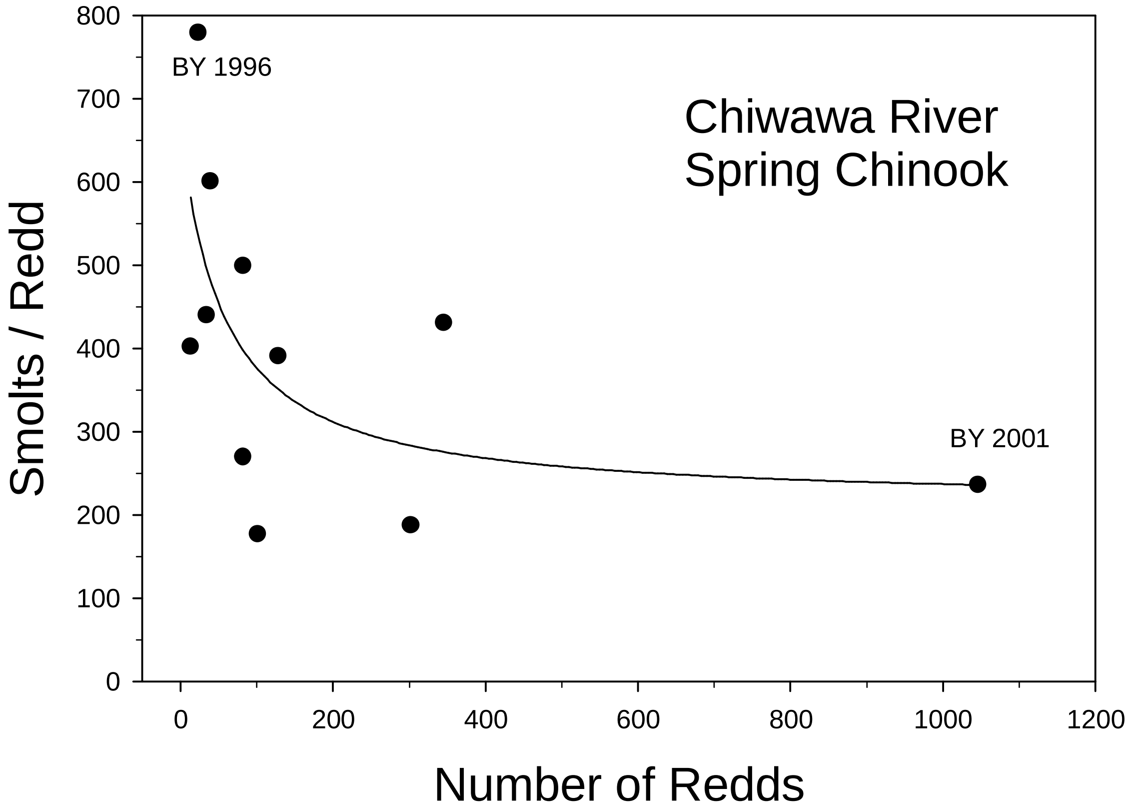

Figure 3.2 A density-dependent relationship between Chinook salmon smolts per redd and the number of redds in the Chiwawa River, a relatively pristine tributary of the Wenatchee River, Washington. Brood years (BY) are only specified for extreme values

4 Delisting Criteria

In the previous sections, this plan described the status of ESA-listed populations in the Upper Columbia Basin and reasons for their decline. In this section, the plan identifies goals, objectives, reclassification criteria and recovery criteria for naturally produced spring Chinook salmon, steelhead, and bull trout in the Upper Columbia Basin. This plan differentiates between “reclassification” and “recovery” criteria (NOAA 2004). “Reclassification” criteria represent the levels of abundance, productivity, spatial structure, and diversity necessary for “endangered” species (spring Chinook) to be classified as “threatened” under the ESA. “Recovery” criteria are the same as “delisting” criteria, which represent the levels of abundance, productivity, spatial structure, and diversity necessary for each species to be removed from ESA listing. Recovery levels are higher than reclassification levels.

It should be noted, however, that these biological criteria (VSP parameters) are only one component of the decision-making process of whether or not listed fish are reclassified and de-listed. Before the species can be reclassified or de-listed, NOAA Fisheries and USFWS must evaluate if the existing and ongoing institutional measures are sufficient to address the threats (see Section 3.11) to protect the viability of the populations and the ESU and DPS.

4.1 Guiding Principles

Although there are no specific regulations regarding recovery, the statutory language of the ESA offers some guidance in recovery planning. Section 4(f) of the ESA addresses the development and implementation of recovery plans. The following are the key provisions of the Act for development of recovery plans:

- 4(f)(1) – Recovery plans shall be developed and implemented for listed species unless the Secretary “…finds that such a plan will not promote the conservation of the species.”
- 4(f)(1)(A) – Priority is to be given, to the maximum extent practicable, to “…species, without regard to taxonomic classification, that are most likely to benefit from such plans, particularly those species that are, or may be, in conflict with construction or other forms of economic activity.”
- 4(f)(1)(B) – Each plan must include, to the maximum extent practicable, “(i) a description of site-specific management actions as may be necessary to achieve the plan’s goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list; and, (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan’s goal and to achieve intermediate steps toward that goal.”

In summary, statutory (e.g., Freedom of Information Act, Federal Advisory Committee Act, Administration Procedure Act, National Environmental Policy Act, Paperwork Reduction Act, and the Information Quality Act) guidance requires certain elements to be included in the plan.

Within these "sideboards," plan developers are given considerable discretion to determine the details of how they develop the plan. This plan is science-based and relied on the guidance provided by the ICBTRT and the Bull Trout Draft Recovery Plan. Delisting criteria were developed by the ICBTRT in concert with the three Eastern Washington Regions (including Tribes), WDFW, and USFWS. The following criteria provide guidance to decision makers within each region.

4.2 Recovery Strategy

At the time of listing, spring Chinook and steelhead in the Upper Columbia Basin exhibited low abundance and productivity (see Section 2). Trends in abundance were mostly downward and replacement ratios were low. Likewise, bull trout abundance in the Upper Columbia Basin was relatively low (see Section 2). Most bull trout populations (or subpopulations) exhibited depressed or unknown trends. Since 2000, naturally produced spring Chinook and steelhead abundance and productivity have increased. However, they still remain at levels that are considered below recovered population levels.

The strategy of this plan is to recommend goals, objectives, and actions that address the primary factors within each "H" (Hydro, Hatchery, Harvest, and Habitat) that limit the abundance, productivity, spatial structure, and diversity of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin.[68] Each action is linked directly to a specific limiting factor (see Section 5). For example, recommended actions within the hydropower system are intended to increase survival of juveniles and adults passing through dams and reservoirs; recommended actions within hatcheries are intended to address abundance, productivity, and diversity issues associated with propagation of stocks; recommended actions within harvest are intended to reduce incidental take of listed species; and recommended actions within habitat are directed at protecting important habitats and minimizing stresses (various land-use and management activities) that degrade spawning and rearing habitat conditions.[69] Ultimately, the implementation of specific recovery actions should lead to the restoration of naturally produced spring Chinook salmon, steelhead, and bull trout populations such that they become viable components of the ecosystem managed within the context of multiple land uses and natural resource management. These actions will also benefit other fish species and some wildlife, and lessen the chance for additional listings in the Upper Columbia Basin.

For all listed species, recovery requires reducing or eliminating threats to the long-term persistence of populations, maintaining widely distributed populations across diverse habitats of their native ranges, and preserving genetic diversity and life history characteristics. Successful recovery of the species means that populations, DPS, and ESU have met certain measurable criteria associated with viable salmonid populations (ICBTRT 2005). This plan focuses on four viable salmonid population (VSP) parameters: abundance, productivity, spatial structure, and

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[68] Note that goals and criteria must be met entirely from naturally produced fish. Hatchery fish are not included in the abundance and productivity criteria.

[69] It is important to note that habitat improvements will reach a point of diminishing returns. In other words, at some point in the future, all improvements, through protection and restoration, will have a very limited affect on fish habitat. This plan promotes an end point of habitat improvements, that when met, will conclude the responsibility of landowner action to improve or preserve habitat (see Section 5).

diversity of naturally produced fish (see ICBTRT 2005a, b for a detailed discussion on VSP parameters) and bull trout goals and objectives. Importantly, this plan does not expect listed species where they did not occur historically, nor does it expect abundances that occurred historically.

4.2.1 Abundance

Population abundance must be large enough to have a high probability of surviving environmental variation observed in the past and expected in the future, to be resilient to environmental and anthropogenic disturbances, to maintain genetic diversity, and to support or provide ecosystem functions. In this plan, the contribution of abundance to recovery will be measured using the twelve-year geometric mean abundance of adult fish on spawning grounds. McElhany (2000) recommended an 8-20 year time period. Ford et al. (2001) recommended a twelve-year time period because it overcomes survey variability, fluctuating environmental conditions, natural fluctuations in population cycles, multiple generations, and is more socially accepted than a 16 or 20-year timeframe. For spring Chinook and bull trout,[70] abundance will be based on redd counts. Because of a lack of long-term steelhead redd counts, abundance of adult steelhead on spawning grounds will be estimated from inter-dam counts and radio-telemetry studies.

4.2.2 Productivity

The productivity of a population is a measure of its ability to sustain itself or its ability to rebound from low numbers. Productivity can be measured as spawner:spawner ratios (a.k.a., returns per spawner or recruits per spawner), annual population growth rate, or trends in abundance of naturally produced fish. This plan uses spawner:spawner ratios as an index of productivity for spring Chinook and steelhead, and trends in redd counts for bull trout. There is currently no information available to estimate spawner:spawner ratios for bull trout. Spawner:spawner ratios for spring Chinook and steelhead will be expressed as the 12-year geometric mean recruits per spawner (following Ford et al. 2001). Stock-recruitment curves will be used to estimate "intrinsic productivity" [71] when high levels of Chinook salmon and steelhead abundance are eventually achieved.

This plan also recognizes the primary importance of smolts/redd as a metric for habitat productivity. That is, in addition to evaluating productivity for the entire life cycle (mean spawner:spawner ratios), this plan uses smolts/redd to isolate the function of tributary habitat, without the confounding effects of mortality outside the subbasin. Although this plan currently lacks the information needed to identify recovery criteria based on smolts/redd, monitoring programs are in place or planned that will allow the use of this index as a consistent approach to evaluating restoration actions in the future.

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[70] The USFWS developed a range of 2 to 2.8 fish/redd to estimate adult abundance (USFWS 2004).
[71] Intrinsic productivity is the expected productivity at low to moderate spawner abundance relative to spawning capacity.

4.2.3 Spatial Structure

Spatial structure concerns the geographic distribution of a population and the processes that affect the distribution. Populations with restricted distributions and few spawning areas are at a higher risk of extinction due to catastrophic environmental events (e.g., a single landslide) than populations with more widespread and complex spatial structures. A population with complex spatial structure will include multiple spawning areas and will allow the expression of natural patterns of gene flow and life history characteristics. Some populations, such as Entiat spring Chinook, have a naturally simple spatial structure and therefore have an inherently higher risk of extinction. As noted earlier, this plan does not expect spatial structure where it did not exist historically. Also, the role of artificial production in spatial structure is not fully understood.

4.2.4 Diversity

Population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genotypic (DNA) characteristics of populations. Because environments continually change due to natural process (e.g., fires, floods, drought, landslides, volcanism, etc.) and anthropogenic influences, populations exhibiting greater diversity are more resilient to both short- and long-term changes. Phenotypic diversity allows more diverse populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genotypic diversity (DNA), on the other hand, provides populations with the ability to survive long-term changes in the environment. It is the combination of phenotypic and genotypic diversity expressed in a natural setting that provides populations with the ability to adapt to long-term changes.

In some cases, the mixing of hatchery fish (or excessive numbers of out-of-basin stocks) with naturally produced fish on spawning grounds can actually decrease genetic diversity within the population (Hallerman 2003). According to the ICBTRT (2005a, b), diversity of naturally produced populations, ESUs, and DPSs can decrease because of hatchery adaptations of domestication, losses of genetic variability through supportive breeding, and erosion of natural population structure through homogenization. Recovery actions should be designed to reduce domestication and homogenization, and prevent gene flow rates greater than natural levels. Hatchery programs that increase genetic diversity should be emphasized.

4.2.5 Combining VSP Parameters

Abundance and productivity are closely linked. That is, rates of productivity at relatively low abundance should be, on average, sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels.[72] In contrast, productivity rates can be closer to 1.0 when population abundance is at target levels. The relationship between productivity and abundance is called a viability curve and it describes those combinations of abundance and productivity that yield a particular risk threshold.

[72] A productivity rate of 1.0 indicates that the population is replacing itself and is stable. A rate less than 1.0 indicates that the population is not replacing itself and is declining. A rate greater than 1.0 indicates that the population is more than replacing itself and is growing.

The ICBTRT has developed viability curves for spring Chinook and steelhead of different population size groups. The ICBTRT identified different size groups based on estimates of historically accessible spawning and rearing habitat. Spring Chinook populations within the Upper Columbia ESU fall within the “basic” (Entiat population) and “large” (Wenatchee and Methow populations) size categories (**Figure 4.1**). Steelhead populations within the Upper Columbia DPS fall within the “basic” (Entiat and Okanogan populations) and “intermediate” (Wenatchee and Methow populations) size categories (**Figure 4.2**). The Okanogan steelhead population is categorized as “basic” in the U.S. and “intermediate” if streams in Canada are included. Further analyses may redefine the minimum numbers for Upper Columbia Basin populations. This could change the designation of populations within the ESU and the DPS in the Upper Columbia Basin.

Viability curves truncate at minimum spawner numbers that differ depending on population size categories. Regardless of population productivity, basic populations must maintain a minimum spawner abundance of 500 spawners, intermediate a minimum of 1,000 spawners, and large populations must maintain a minimum of 2,000 spawners to be considered viable. These minimum levels were developed by the ICBTRT (2005a, b). Note that the area above the viability curves indicates that the populations are at a low risk of extinction, while areas below the curves represent high risk. Under historical conditions, it is likely that most populations demonstrated combinations of intrinsic production potential and abundance above the 5% viability curve. There are no viability curves for bull trout and therefore separate criteria are identified for bull trout abundance and productivity (see Section 4.4.3).

Spatial structure and diversity are also closely related. Because spatial structure is the process that drives diversity, the two (spatial structure and diversity) are very difficult to separate (ICBTRT 2005a, b). Therefore, following the recommendations of the ICBTRT (2005a, b), this plan will evaluate spatial structure and diversity together. The mechanisms, factors, and metrics used to assess spatial structure and diversity are presented in **Table 4.1**. Further analyses may redefine the factors and metrics used to assess spatial structure and diversity. This could change the designation of populations within the ESU and DPS in the Upper Columbia Basin.

4.3 Recovery Goals and Objectives

The overall goal of this plan is recovery of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin.

The specific goal for spring Chinook and steelhead is:

- **To secure long-term persistence of viable populations of naturally produced spring Chinook and steelhead distributed across their native range.**

The specific goal for bull trout is:

- **To secure long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed across the native range of the species.**

4.3.1 Spring Chinook

Because spring Chinook are currently listed as endangered under the ESA (64 FR 14307), this plan identifies two levels of objectives for them. The first identifies objectives related to reclassifying the species as threatened and the second relate to recovery. Recovery of the spring Chinook ESU will require the recovery of the Wenatchee, Entiat, and Methow populations (ICBTRT 2005a, b). This deviates from the recent recommendation of the ICBTRT that at least two populations must meet abundance/productivity criteria that represent a 1% extinction risk over a 100-year period. This plan requires that all spring Chinook populations within the ESU must meet abundance/productivity criteria that represent a 5% extinction risk over a 100- year period.

Reclassification Objectives

Abundance/Productivity

Increase the abundance and productivity of naturally produced spring Chinook within each population in the Upper Columbia ESU to levels that would lead to reclassification of the ESU as threatened under the ESA.

Spatial Structure/Diversity

Increase the current distribution of naturally produced spring Chinook in the Upper Columbia ESU and conserve genetic and phenotypic diversity.

Recovery Objectives

Abundance

Increase the abundance of naturally produced spring Chinook spawners within each population in the Upper Columbia ESU to levels considered viable.

Productivity

Increase the productivity (spawner:spawner ratios and smolts/redds) of naturally produced spring Chinook within each population to levels that result in low risk of extinction.[73]

Spatial Structure/Diversity

Restore the distribution of naturally produced spring Chinook to previously occupied areas (where practical) and allow natural patterns of genetic and phenotypic diversity to be expressed.

4.3.2 Steelhead

As of June 2007, steelhead are again listed as endangered under the ESA. (See 1.4.2 for information about changes in the steelhead listing status).Therefore, this plan identifies two levels of objectives for them. The first identifies objectives related to reclassifying the species as threatened and the second relate to recovery. Recovery of the Upper Columbia Steelhead DPS will require the recovery of the Wenatchee, Entiat, Methow, and Okanogan populations, but not the Crab Creek population (ICBTRT 2005a, b). This deviates from the recent recommendation of the ICBTRT that at least two populations within the DPS must meet abundance/productivity criteria that represent a 1% extinction risk over a 100-year period. This plan requires that all

[73] Low risk is defined as no more than a 5% probability of going below 5 spawners per year for a generation (typically 4-5 years) in a 100-year period (ICBTRT 2005a).

steelhead populations, except the Crab Creek population, must meet abundance/productivity criteria that represent a 5% extinction risk over a 100-year period.

Reclassification Objectives

Abundance/Productivity

Increase the abundance and productivity of naturally produced steelhead within each population in the Upper Columbia DPS to levels that would lead to reclassification of the DPS as threatened under the ESA.

Spatial Structure/Diversity

Increase the current distribution of naturally produced steelhead in the Upper Columbia DPS and conserve genetic and phenotypic diversity.

Recovery Objectives

Abundance

Increase the abundance of naturally produced steelhead spawners within each population in the Upper Columbia DPS to levels considered viable.

Productivity

Increase the productivity (spawner:spawner ratios) of naturally produced steelhead within each population to levels that result in low risk of extinction.

Spatial Structure/Diversity

Restore the distribution of naturally produced steelhead to previously occupied areas (where practical) and allow natural patterns of genetic and phenotypic diversity to be expressed.

4.3.3 Bull Trout

Bull trout in the Upper Columbia Basin are currently listed as threatened under the ESA (63 FR 31647). Therefore this plan only identifies delisting or recovery objectives. It is important to note that core populations within the Upper Columbia Basin make up only a portion of the total Columbia Basin population.

Recovery Objectives

Abundance

Increase the abundance of adult bull trout within each core population in the Upper Columbia Basin to levels that are considered self-sustaining.

Productivity

Maintain stable or increasing trends in abundance of adult bull trout within each core population in the Upper Columbia River Basin.

Spatial Structure/Diversity

Maintain the current distribution of bull trout in all local populations, restore distribution to previously occupied areas (where practical), maintain and restore the migratory form and connectivity within and among each core area, conserve genetic diversity, and provide for genetic exchange.

4.4 Recovery Criteria

This section identifies the reclassification and recovery criteria for each objective. Although criteria must be measurable and objective, they need not all be quantitative (NMFS 2004). The purpose of criteria is to assess whether actions are resulting in recovery of listed species in the Upper Columbia Basin. The criteria developed for recovery of spring Chinook, steelhead, and bull trout address quantitative and qualitative measurements of abundance, productivity, and spatial structure/diversity on a population or core population basis.

4.4.1 Spring Chinook

The following criteria must be met before the Upper Columbia Spring Chinook ESU can be reclassified as threatened and ultimately recovered. The UCSRB recommended these criteria based on information contained in ICBTRT (2005a) and Ford et al. (2001). This information included intrinsic potential, population viability analysis, habitat capacity estimates, and historical run sizes.

Reclassification Criteria

Abundance/Productivity

Criterion 1: The 8-year[74] geometric mean for abundance and productivity of naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations must fall above the 10% extinction-risk (viability) curves shown in Figure 4.1.

Spatial Structure/Diversity

Criterion 2: The ***mean*** score for the three metrics of natural rates and levels of spatially mediated processes (Goal A) will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all threats for "high" risk have been addressed (see **Table 4.1** and Appendix B; ICBTRT 2005a).

Criterion 3: The ***mean*** score[75] for the eight metrics of natural levels of variation (Goal B) will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all threats for "high" risk have been addressed (see **Table 4.1** and Appendix B; ICBTRT 2005a).

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[74] An 8-year timeframe represents at least two generations.

[75] Averaging the metrics to calculate Goal B scores lowers the bar for reclassification. The spatial structure and diversity matrix developed by the ICBTRT (2005a) assesses risk for Goal B by weighting the lowest score. Thus, risk under Goal B is weighted heavily toward those metrics that have low scores (see Appendix B). By averaging the metrics, each metric receives equal weight and the resulting score will be higher than using the method proposed by the ICBTRT.

Recovery Criteria

Abundance/Productivity

Criterion 1: The 12-year geometric mean for abundance and productivity of naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations must fall above the 5% extinction-risk (viability) curves shown in **Figure 4.1**.

Criterion 2: At a minimum, the Upper Columbia Spring Chinook ESU will maintain at least 4,500 naturally produced spawners and a spawner:spawner ratio greater than 1.0 distributed among the three populations as follows:[76]

Population	Minimum 12-yr GM Spawners	Minimum 12-yr GM Spawner:spawner[77]
Wenatchee	2,000	1.2
Entiat	500	1.4
Methow	2,000	1.2
Total for ESU	**4,500**	**>1.0**

Spatial Structure/Diversity

Criterion 3: Over a 12-year period, naturally produced spring Chinook will use currently occupied major spawning areas (minor spawning areas are addressed primarily under Criteria 4 and 5)[78] throughout the ESU according to the following population-specific criteria (**Figures 4.3-4.5**):

Wenatchee

Naturally produced spring Chinook spawning will occur within the four of the five major spawning areas in the Wenatchee subbasin (Chiwawa River, White River, Nason Creek, Little Wenatchee River, or Wenatchee River) and within one minor spawning area downstream from Tumwater Canyon (Chumstick, Peshastin, Icicle, or Mission). The minimum number of naturally produced spring Chinook redds within each major spawning area will be either 5% of the total number of redds within the Wenatchee subbasin or at least 20 redds within each major area, whichever is greater (adapted from Ford et al. 2001).

Entiat

Naturally produced spring Chinook will spawn within the one major spawning area within the Entiat subbasin.

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[76] This is a minimum criterion for abundance and productivity. Because of variability in the estimates, the criteria may not represent a 5% risk of extinction within 100 years, but likely a higher extinction risk.
[77] These values represent the minimum growth rates associated with the minimum number of spawners of a viable population.
[78] Based on local knowledge of the subbasins, this plan modified the major and minor spawning areas identified by the ICBTRT.

Methow

Naturally produced spring Chinook spawning will occur within the Twisp, Chewuch, and Upper Methow major spawning areas. The minimum number of naturally produced spring Chinook redds within each major spawning area will be either 5% of the total number of redds within the Methow subbasin or at least 20 redds within each major area, whichever is greater (adapted from Ford et al. 2001).

Okanogan

Recovery of spring Chinook in the Okanogan Subbasin is not a requirement for delisting because the ICBTRT determined that this population was extinct (ICBTRT 2005a). However, this plan recognizes that if a major spawning area could be established in the Okanogan using an Upper Columbia spring Chinook stock, then the ESU would be at a lower risk of extinction.

Areas Upstream from Chief Joseph

Recovery of spring Chinook in areas upstream from Chief Joseph Dam is not a requirement for delisting because the ICBTRT determined that these populations and major population groups were extinct (ICBTRT 2005a). However, this plan recognizes that if a major spawning area could be established in the area upstream from Chief Joseph Dam using an Upper Columbia spring Chinook stock, then the ESU would be at a lower risk of extinction.

Criterion 4: The ***mean*** score for the three metrics of natural rates and levels of spatially mediated processes (Goal A) will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all threats for "high" risk have been addressed (see **Table 4.1** and Appendix B; ICBTRT 2005a).

Criterion 5: The score[79] for the eight metrics of natural levels of variation (Goal B) will result in a ***moderate*** or lower risk assessment for naturally produced spring Chinook within the Wenatchee, Entiat, and Methow populations and all threats for "high" risk have been addressed (see **Table 4.1** and Appendix B; ICBTRT 2005a).

4.4.2 Steelhead

The following criteria must be met before the Upper Columbia Steelhead DPS can be classified as recovered. The UCSRB recommended these criteria based on information contained in ICBTRT (2005a) and Ford et al. (2001). This information included intrinsic potential analysis, population viability analysis, habitat capacity estimates, and historical run sizes.

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[79] Scoring for Goal B under recovery follows the criteria provided by the ICBTRT (2005a). This means that metrics under Goal B with the lowest score receive greater weight than metrics with higher scores (see Appendix B).

Steelhead Reclassification Criteria

- Abundance and productivity (based on 8-year geometric mean) of naturally produced steelhead with in the Wenatchee, Entiat, Methow, and Okanogan populations must reach levels that would have less than a 10% risk of extinction over a 100-year period.
- Processes affecting spatial structure must result in at least a **moderate** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered "high" risk will have been addressed.
- Processes affecting diversity will result in at least a **moderate** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all factors considered "high" risk will have been addressed.

Recovery Criteria

Abundance/Productivity

Criterion 1: The 12-year geometric mean for abundance and productivity of naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations must fall above the 5% extinction-risk (viability) curves shown in **Figure 4.2**.

Criterion 2: At a minimum, the Upper Columbia steelhead DPS will maintain at least 3,000 spawners and a spawner:spawner ratio greater than 1.0 distributed among the four populations as follows:[80]

Population	Minimum 12-yr GM Spawners	Minimum 12-yr GM Spawner:Spawner[81]
Wenatchee	1,000	1.1
Entiat	500	1.2
Methow	1,000	1.1
Okanogan	500[82]	1.2
Total for DPS	**3,000**	**>1.0**

[80] This is a minimum criterion for abundance and productivity. Because of variability in the estimates, the criteria may not represent a 5% risk of extinction within 100 years, but likely a higher extinction risk.
[81] These values represent the minimum growth rates associated with the minimum number of spawners of a viable population.
[82] The ICBTRT has determined that 500 naturally produced steelhead adults will meet the minimum abundance recovery criteria within the U.S. portion of the Okanogan subbasin. If the Canadian portion of the Okanogan subbasin was included, the minimum abundance recovery criteria would be 1,000 naturally produced steelhead adults. Voluntary and bilateral efforts are underway to coordinate actions to meet this goal.

Spatial Structure/Diversity

Criterion 3: Over a 12-year period, naturally produced steelhead will use currently occupied major spawning areas (minor spawning areas are addressed primarily under Criteria 4 and 5) throughout the ESU according to the following population-specific criteria (**Figures 4.6-4.9**):

Wenatchee

Naturally produced steelhead spawning will occur within four of the five major spawning areas in the Wenatchee Subbasin (Chiwawa River, Nason Creek, Icicle Creek, Peshastin Creek, or Chumstick Creek). The minimum number of naturally produced steelhead redds within four of the five major spawning areas will be either 5% of the total number of redds within the Wenatchee population or at least 20 redds within each of four of the five major areas, whichever is greater (adapted from Ford et al. 2001).

Entiat

Naturally produced steelhead will spawn within the two major spawning area within the Entiat subbasin (Upper Entiat and Mad rivers). The minimum number of naturally produced steelhead redds within the two major spawning areas will be either 5% of the total number of redds within the Entiat population or at least 20 redds within each major area, whichever is greater (adapted from Ford et al. 2001).

Methow

Naturally produced steelhead spawning will occur within the three of the four major spawning areas (Twisp, Chewuch, Beaver, or Upper Methow). The minimum number of naturally produced steelhead redds within each major spawning area will be either 5% of the total number of redds within the Methow subbasin or at least 20 redds within each major area, whichever is greater (adapted from Ford et al. 2001).

Okanogan

Steelhead spawning will occur within the two major spawning areas (Salmon and Omak creeks) and within at least two of the five minor spawning areas (Ninemile, Whitestone, Bonaparte, Antoine, or Loup Loup). The minimum number of naturally produced steelhead redds within three of the four spawning areas will be either 5% of the total number of redds within the Okanogan subbasin or at least 20 redds within each area, whichever is greater (adapted from Ford et al. 2001).

Areas Upstream from Chief Joseph

Recovery of steelhead in areas upstream from Chief Joseph Dam is not a requirement for delisting, because the ICBTRT determined that these populations and major population groups were extinct (ICBTRT 2005a). However, this plan recognizes that if a major spawning area could be established in the area upstream from Chief Joseph Dam using an Upper Columbia steelhead stock, then the DPS would be at a lower risk of extinction.

Crab Creek

This plan does not address recovery criteria for the Crab Creek steelhead population. As described in Section 1.3.6, recovery of the Crab Creek population is not needed for the recovery of the Upper Columbia steelhead DPS. However, this plan recognizes that if a major spawning area could be established in the Crab Creek subbasin, then the DPS would be at a lower risk of extinction.

Criterion 4: The ***mean*** score for the three metrics of natural rates and levels of spatially mediated processes (Goal A) will result in a ***moderate*** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all threats for "high" risk have been addressed (see **Table 4.1Error! Reference source not found.** and Appendix B; ICBTRT 2005a, b).

Criterion 5: The score for the eight metrics of natural levels of variation (Goal B) will result in a ***moderate*** or lower risk assessment for naturally produced steelhead within the Wenatchee, Entiat, Methow, and Okanogan populations and all threats for "high" risk have been addressed (see **Table 4.1** and Appendix B; ICBTRT 2005a, b).

4.4.3 Bull Trout

The following criteria for Upper Columbia bull trout must be met before the Columbia River bull trout population can be recovered. The USFWS recommended these criteria, which were based on habitat capacity estimates, effective population size estimates, and conservation principles and guidelines (USFWS 2002, 2004, 2005).

Recovery Criteria

Abundance

Criterion 1: The abundance of Upper Columbia bull trout will increase and maintain a 12-year geometric mean of 4,144-5,402 spawners (range is based on 2-2.8 fish/redd), distributed among the three core areas as follows:

Population	Minimum 12-yr GM Spawners
Wenatchee	1,612-2,257
Entiat	298-417
Methow	1,234-1,728[83]
Total	**4,144-5,402**

Productivity

Criterion 2: The trend in numbers of bull trout redds (an index of numbers of spawners) within each population in the core areas (Wenatchee, Entiat, and Methow) are stable or increasing over a 12-year period.

[83] This criterion does not include bull trout in the Lost River drainage.

Spatial Structure/Diversity

Criterion 3: Bull trout will use currently occupied spawning areas and "potential" areas currently not occupied throughout the Upper Columbia Basin according to the following population-specific criteria:

Wenatchee

Bull trout spawning will occur within the seven interconnected areas (Chiwawa, White, Little Wenatchee, Nason, Icicle, Chiwaukum, and Peshastin), with 100 or more adults spawning annually within three to five areas.

Entiat

Bull trout spawning will occur within the two interconnected areas (Entiat and Mad), with 100 or more adults spawning annually in each area.

Methow

Bull trout spawning will occur within the ten interconnected areas (Gold, Twisp, Beaver, Chewuch, Lake Creek, Wolf, Early Winters, Upper Methow, Goat, and Lost), with 100 or more adults spawning annually within three to four areas.

Criterion 4: The migratory form of bull trout and connectivity within and among core areas must be present.

4.5 Recovery Timeframe

The time required to achieve reclassification (for spring Chinook and steelhead) and recovery of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin depends on the species status, factors currently affecting their viability, implementation and effectiveness of recovery actions, and responses to actions. A large amount of work within <u>all</u> sectors (i.e., Hs) will be needed to recover the ESU, the DPS, and their populations. In addition, long periods of time may be needed before some habitat actions result in measurable effects on species viability parameters. What follows are best estimates of the time required to meet recovery if the actions identified within this plan are implemented.

4.5.1 Spring Chinook

Reclassification

Based on the current status of spring Chinook (i.e., increasing abundance and productivity), reclassification could occur within 5-15 years.[84]

Recovery

If the actions identified in this plan are implemented and out-of-ESU conditions continue to improve, recovery of Upper Columbia spring Chinook could occur within 10-30 years.

[84] Because recovery status is retroactive, the "good" returns since 2000 will be included in the geometric means. Thus, reclassification could occur within a few years after this plan is adopted.

4.5.2 Steelhead

Reclassification

Based on the current status of steelhead (i.e., increasing abundance and productivity), reclassification could occur within 5-15 years.

Recovery

If the actions identified in this plan are implemented and out-of-DPS conditions continue to improve, recovery of Upper Columbia steelhead could occur within 10-30 years.

4.5.3 Bull Trout

Recovery

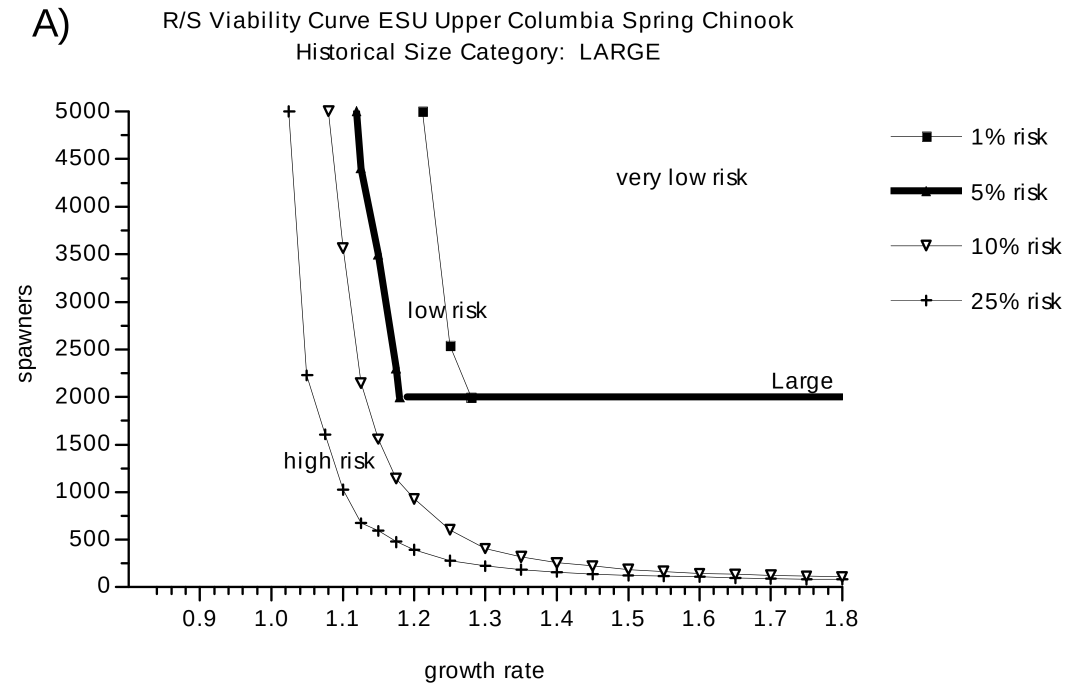
If the actions identified in this plan are implemented, then at least the Upper Columbia component of the Columbia River population could meet recovery criteria within 15-25 years.[85]

[85] The Upper Columbia is a portion of the Columbia DPS; therefore, to reach recovery it is necessary that the entire DPS meet recovery criteria.

Table 4.1 Mechanisms, factors, and metrics used to assess spatial structure and diversity of spring Chinook and steelhead populations in the Upper Columbia Basin. Table is from ICBTRT (2005a,b)

Goal	Mechanism	Factor	Metrics
A. Allow natural rates and levels of spatially mediated processes.	1. Maintain natural distribution of spawning aggregates.	a. Number and spatial arrangement of spawning areas.	Number of MSAs, distribution of MSAs, and quantity of habitat outside MSAs.
		b. Spatial extent or range of population	Proportion of historical range occupied and presence/absence of spawners in MSAs.
		c. Increase or decrease gaps or continuities between spawning aggregates.	Change in occupancy of MSAs that affects connectivity within the population.
B. Maintain natural levels of variation.	1. Maintain natural patterns of phenotypic and genotypic expression.	a. Major life history strategies.	Distribution of major life history expression within a population.
		b. Phenotypic variation.	Reduction in variability of traits, shift in mean value of trait, loss of traits.
		c. Genetic variation.	Analysis addressing within and between population genetic variations.
	2. Maintain natural patterns of gene flow.	a. Spawner composition	(1) Proportion of hatchery origin natural spawners derived from a local (within population) brood stock program using best practices.
			(2) Proportion of hatchery origin natural spawners derived from a within MPG brood stock program, or within population (not best practices) program.
			(3) Proportion of natural spawners that are unnatural out-of-MPG strays.
			(4) Proportion of natural spawners that are unnatural out-of-ESU and -DPS strays.
	3. Maintain occupancy in a natural variety of available habitat types.	a. Distribution of population across habitat types.	Change in occupancy across ecoregion types.
	4. Maintain integrity of natural systems.	a. Selective change in natural processes or impacts.	Ongoing anthropogenic activities inducing selective mortality or habitat change within or out of population boundary

Wenatchee and Methow



Entiat

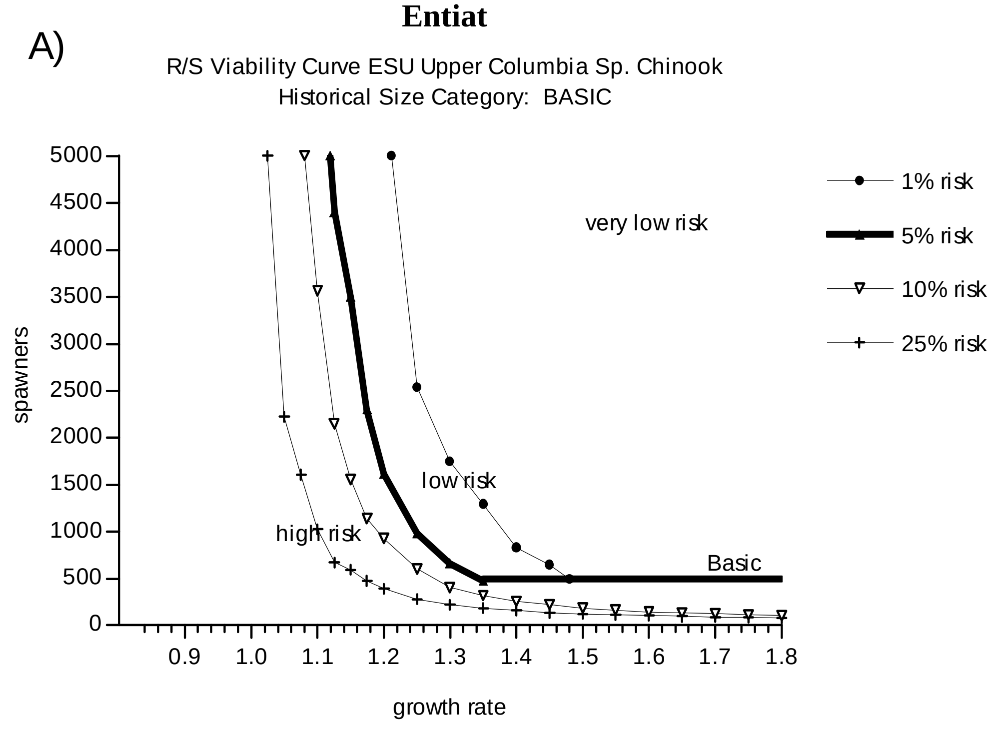
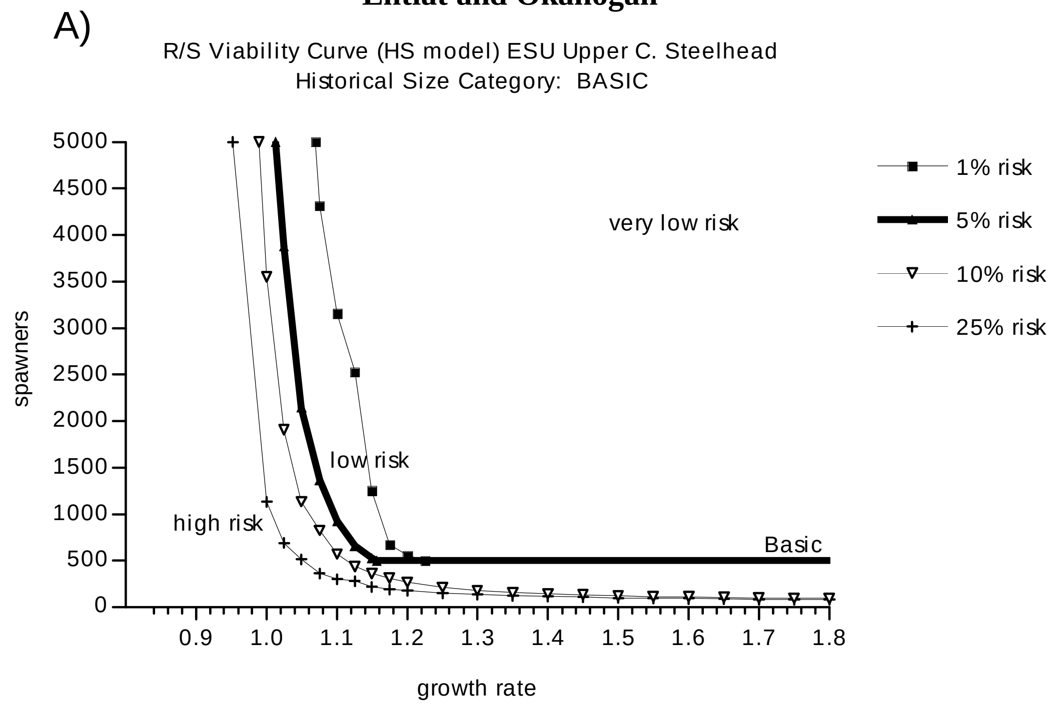


Figure 4.1 Viability curves for Upper Columbia spring Chinook. The ***top figure*** represents the Wenatchee and Methow Entiat populations and the ***bottom figure*** represents the Entiat population.

Entiat and Okanogan



Wenatchee and Methow

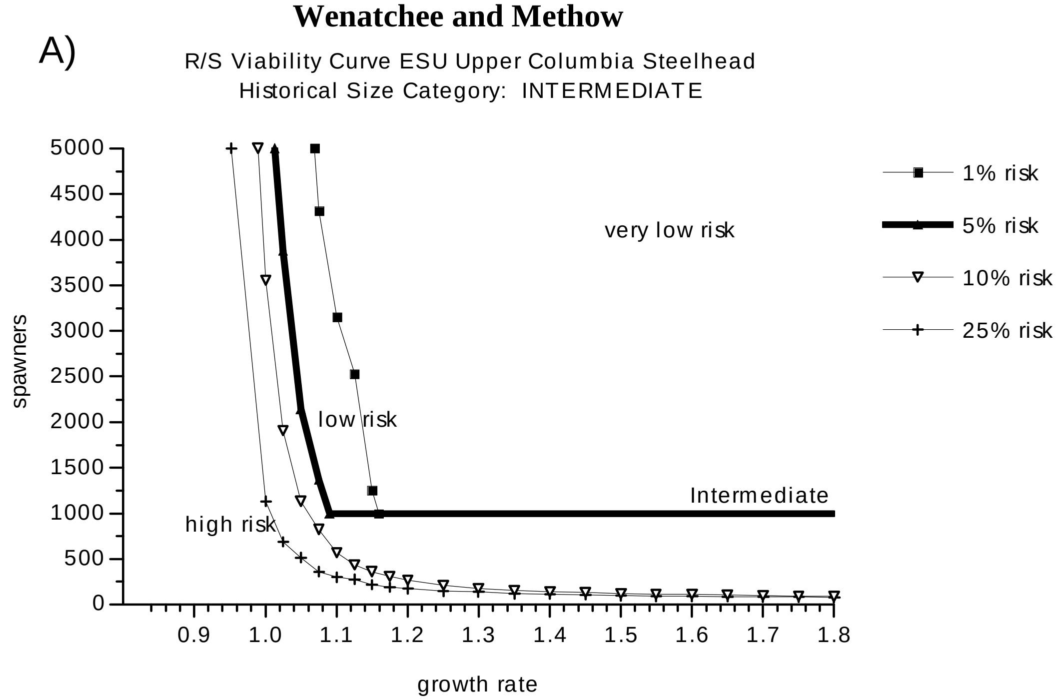


Figure 4.2 Viability curves for Upper Columbia steelhead. The ***top figure*** represents the Entiat and Okanogan populations and the ***bottom figure*** represents the Wenatchee and Methow populations.

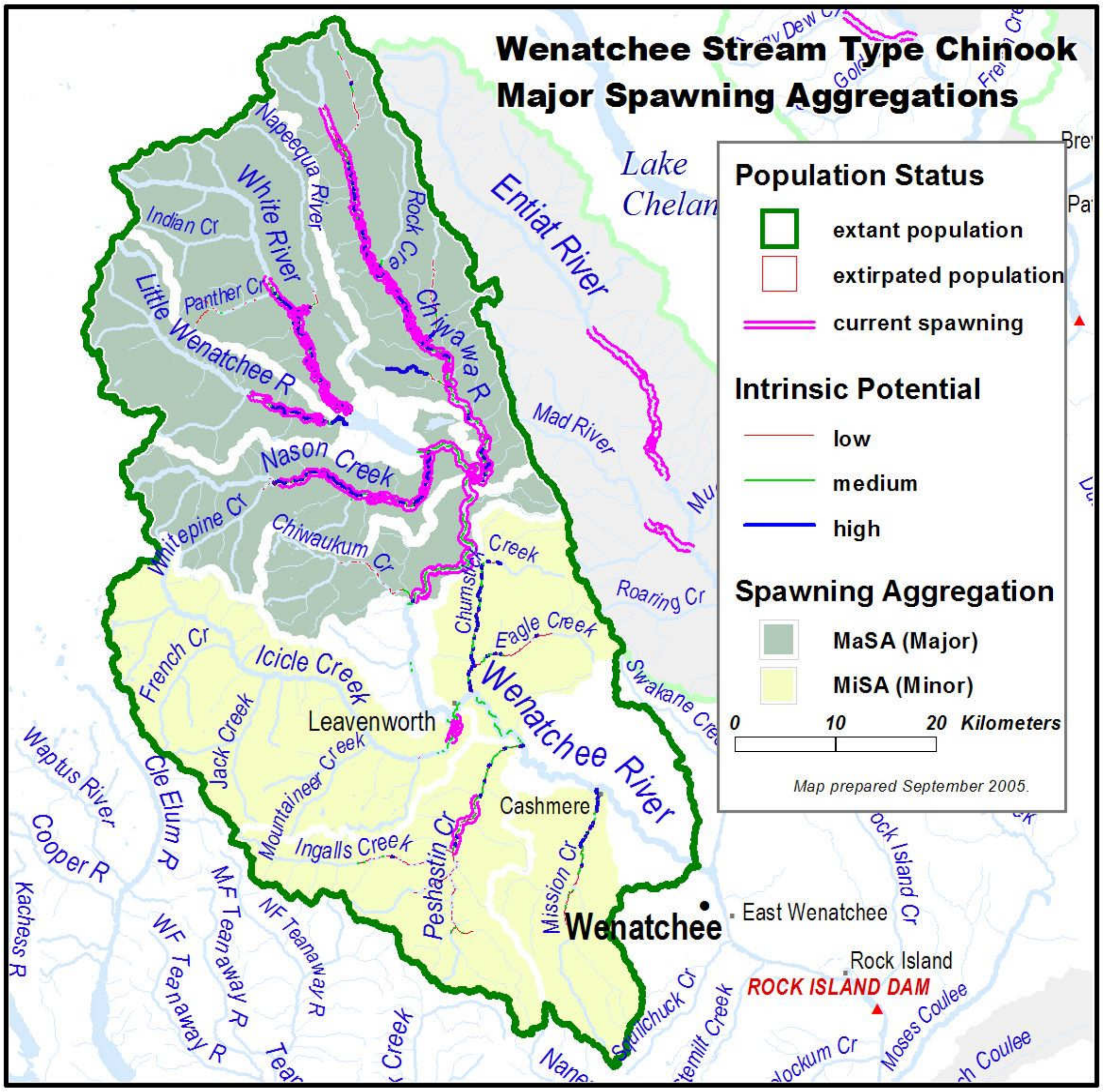


Figure 4.3 Distribution of major and minor spawning areas of spring Chinook in the Wenatchee Subbasin

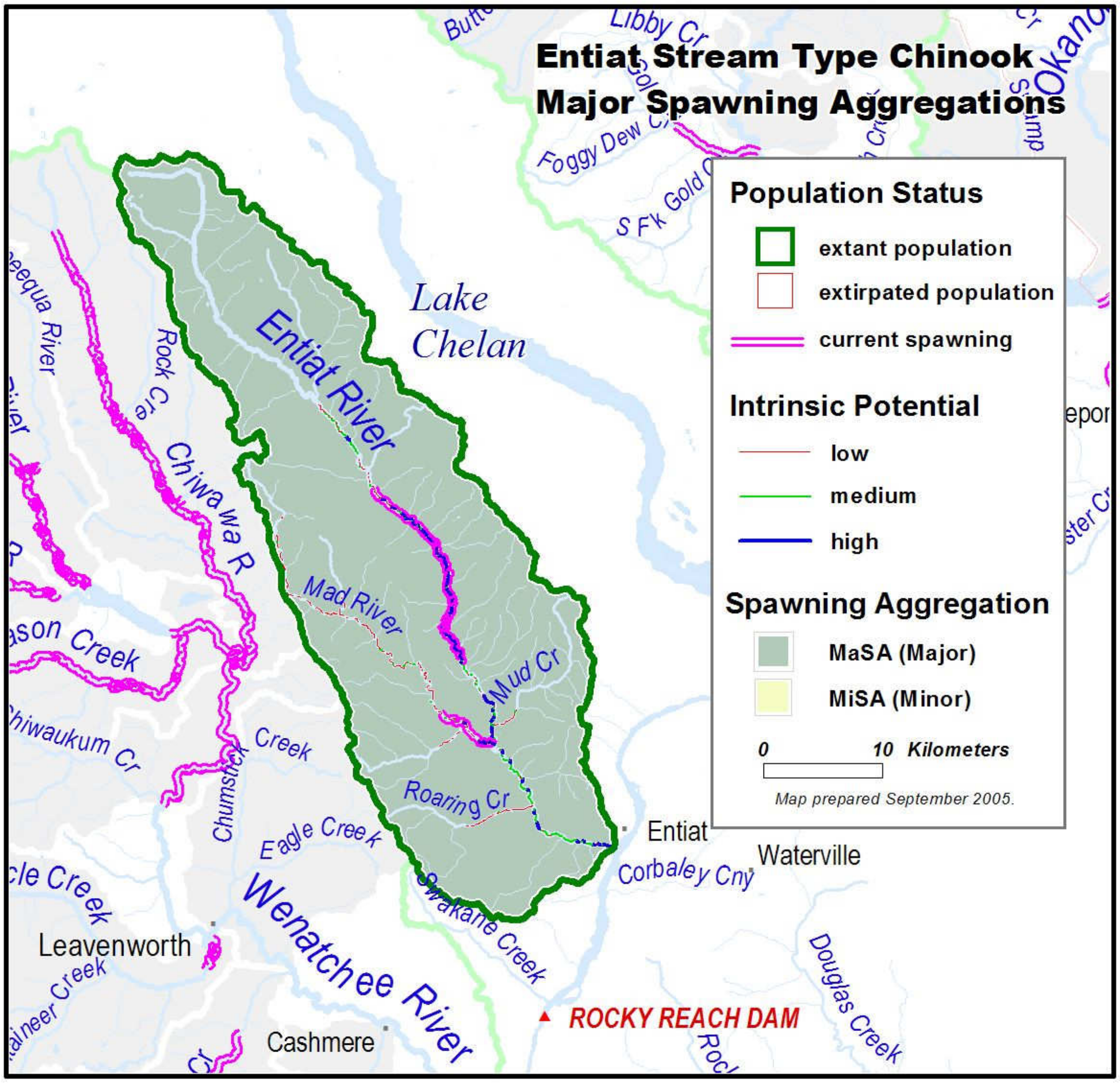


Figure 4.4 Distribution of major and minor spawning areas of spring Chinook in the Entiat Subbasin

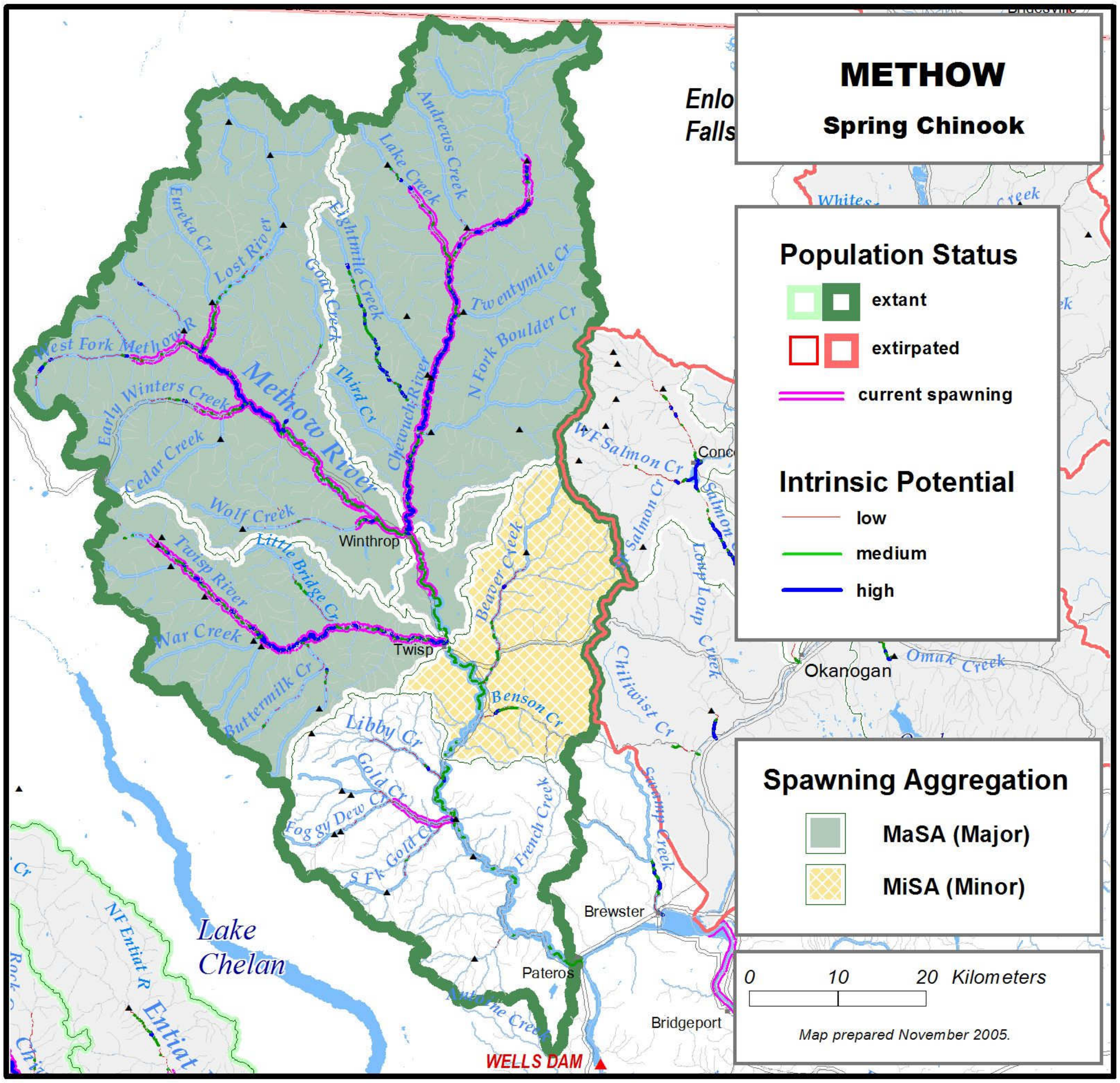


Figure 4.5 Distribution of major and minor spawning areas of spring Chinook in the Methow Subbasin

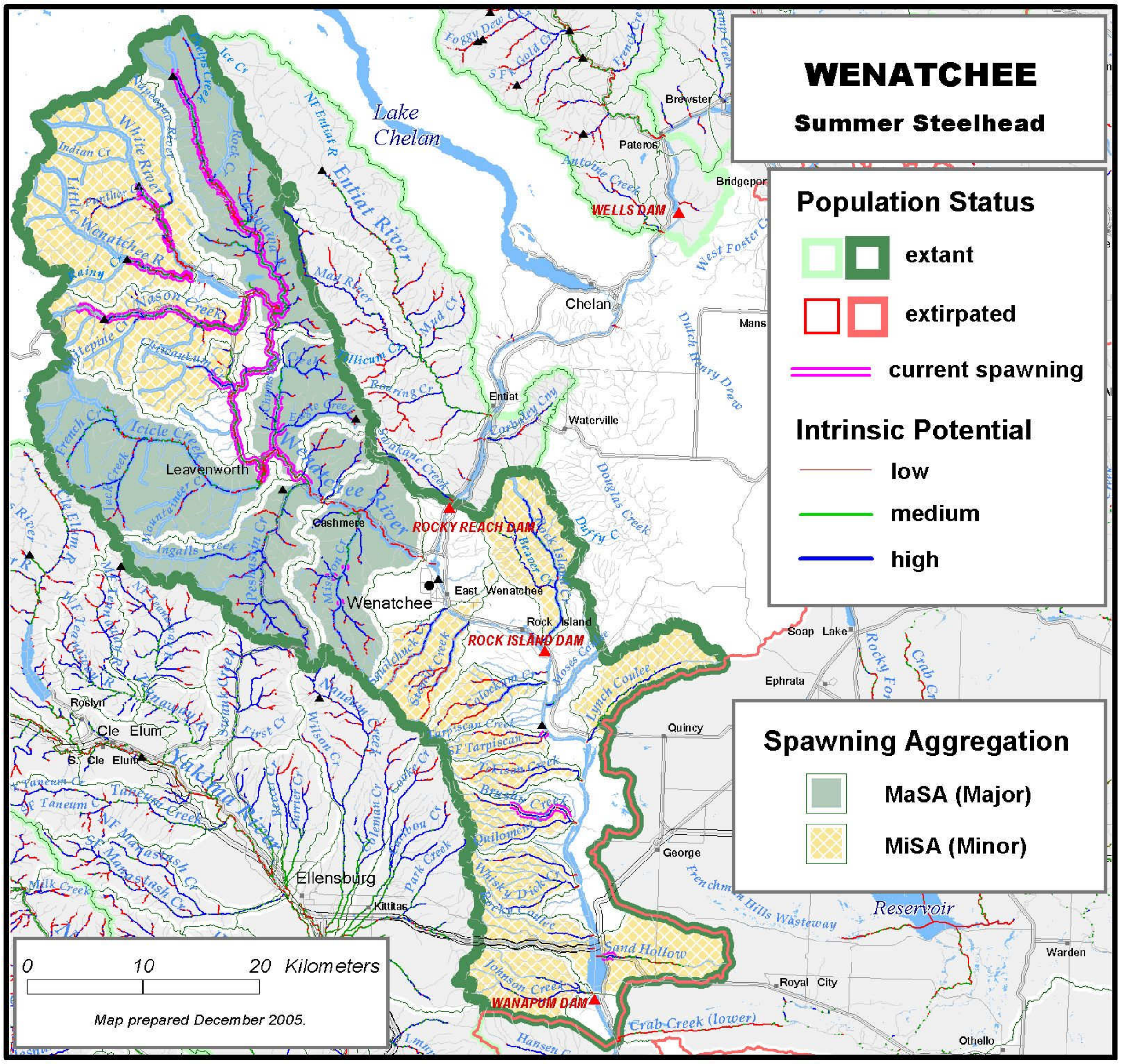


Figure 4.6 Distribution of major and minor spawning areas of steelhead in the Wenatchee Subbasin

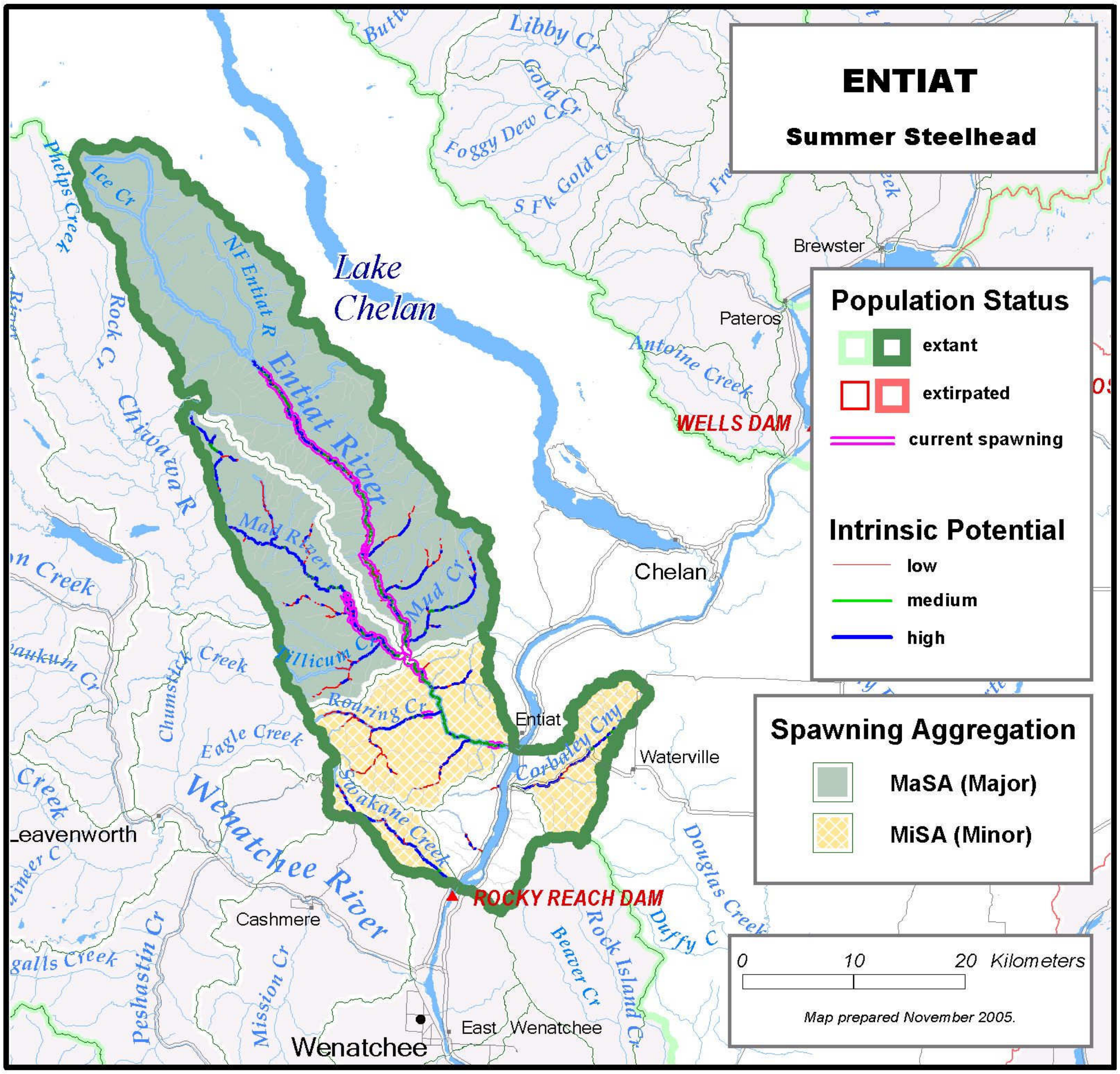


Figure 4.7 Distribution of major and minor spawning areas of steelhead in the Entiat Subbasin

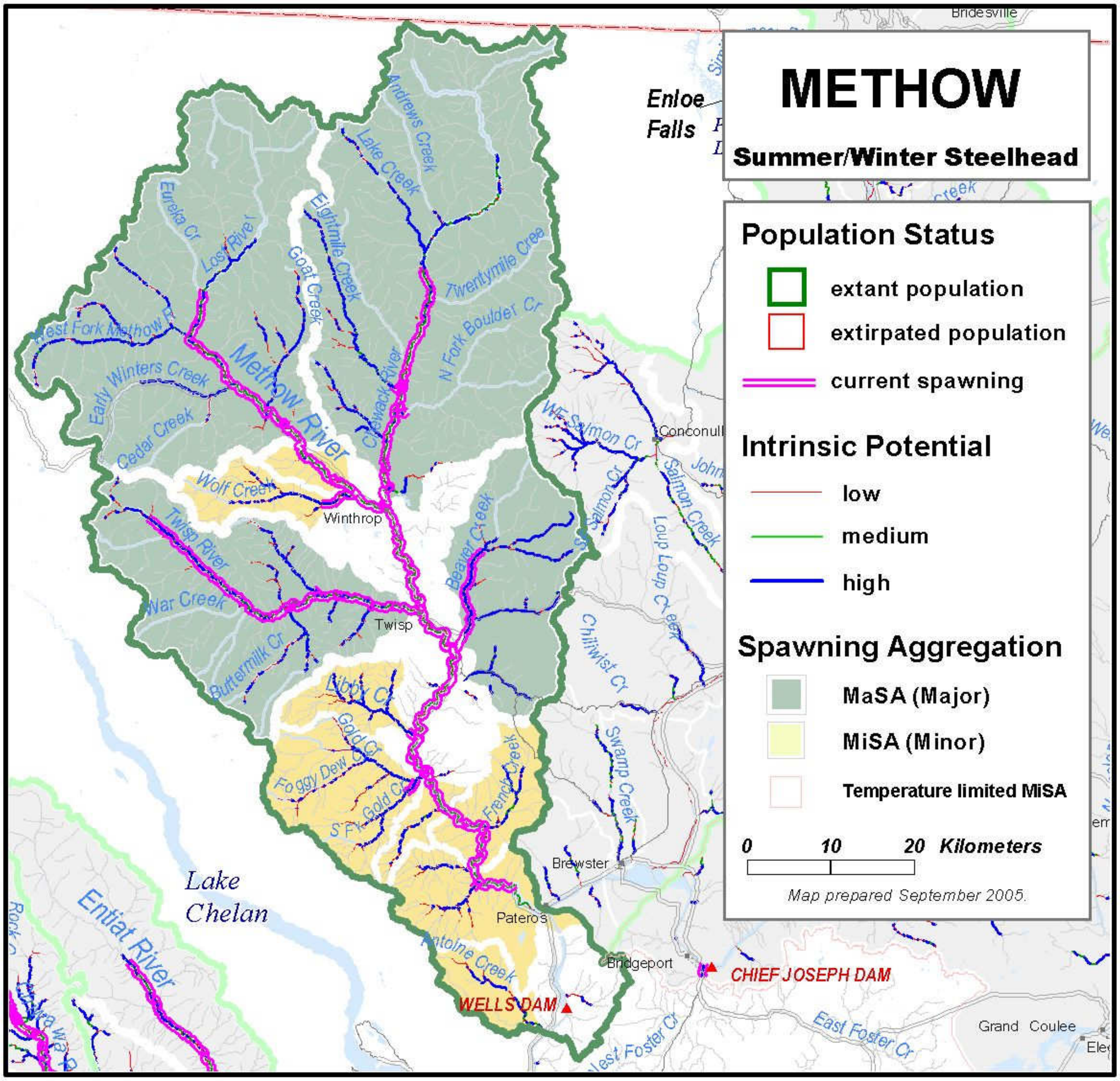


Figure 4.8 Distribution of major and minor spawning areas of steelhead in the Methow Subbasin

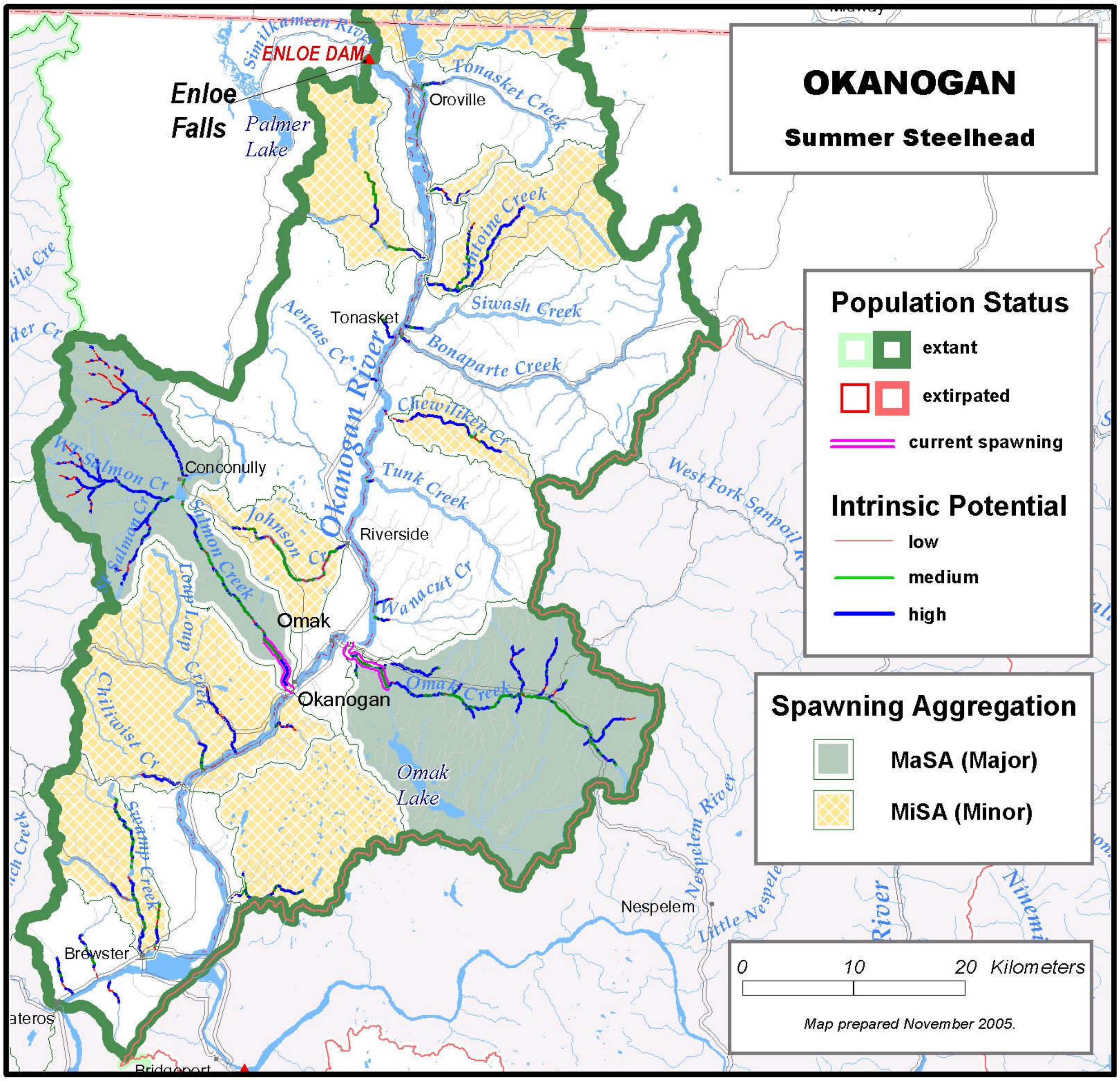


Figure 4.9 Distribution of major and minor spawning areas of steelhead in the Okanogan Subbasin

5 Strategy for Recovery

This section of the recovery plan recommends recovery actions that are necessary to achieve the goals and objectives of the plan. It identifies and describes all recommended actions that will alleviate known threats and restore spring Chinook, steelhead, and bull trout populations in the Upper Columbia Basin to viable and sustainable levels. This section will provide guidance to resource managers, resource users, and landowners regarding the goals of the plan and actions needed to achieve recovery.

5.1 Overview

This plan recommends recovery actions for all Hs (Harvest, Hatchery, Hydro, and Habitat) that affect populations of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Some of the H-specific actions identified in this plan were developed in other forums or processes and are incorporated with little or no modification. Several have already been implemented to the benefit of one or more of the VSP parameters (abundance, productivity, spatial structure, and diversity) of populations in the Upper Columbia Basin. Actions already implemented must be continued, monitored, refined, and expanded depending on new information derived from monitoring and evaluation and evolving science. However, it is clear that additional actions are necessary to achieve recovery of these populations.

The following guidelines, as modified by the UCSRB, were applied in selecting and describing recovery actions across Hs (NMFS 2004).

- Recovery actions should be discrete and action oriented.
- Whenever possible, recovery actions should be site-specific, as per ESA Section 4(f)(1)(B)(i).
- Recovery actions should be feasible, have broad public support, and have adequate funding.
- The plan should include both near-term (those that prevent population extinction or decline) and long-term (those that lead to recovery) actions.

As noted above, a number of forums have already identified and implemented actions intended to improve the status of listed Upper Columbia Basin species and will continue to do so. For example, subbasin and watershed plans identified actions within each of the subbasins that would benefit ESA-listed species in the Upper Columbia Basin. Similarly, specific actions that will benefit listed species have been identified in either Habitat Conservation Plans or Settlement Agreements for the hydropower projects owned by the PUDs in the Upper Columbia Basin and in Biological Opinions covering operations of the Federal Columbia River Power System (FCRPS). Harvest management regimes governing specific mainstem Columbia River fisheries have been developed and applied by the ***U.S. v Oregon*** parties since before the ESA listings of Upper Columbia Chinook and steelhead, and refined several times since the listings. Similarly, hatchery management has been reformed significantly throughout the Columbia Basin since the ESA listings. These hatchery reforms, described in detailed Hatchery and Genetics Management Plans (HGMPs) are designed to address requirements of the ESA, but also represent an evolving scientific understanding of the positive and negative effects of hatcheries on the viability of naturally produced populations. Most, if not all, of the above plans have been evaluated in ESA consultations that resulted in the issuance of Biological Opinions and when necessary, ESA permits.

Most of the actions identified in those forums meet the guidelines listed above, as do the additional actions identified in this plan. However, habitat-related actions identified in subbasin and watershed plans usually lacked prioritization. In this plan, actions were prioritized based on professional opinion, public input, and EDT modeling. This plan relied heavily on the priority of habitat actions identified in the Upper Columbia Regional Technical Team (UCRTT) Biological Strategy (UCRTT 2003). This is covered in more detail in Sections 5.5 and 8.3. It is presumed that actions within all sectors (i.e., all Hs) are necessary to achieve recovery (see Section 5.6), but because different sectors involve different parties, different decision-making processes, and different timelines, this plan respects those differences and does not attempt to prioritize actions across Hs. Actions within each sector, however, have been identified by those parties and processes and are described and categorized in this plan as short-term (those that prevent extinction or decline of populations) and long-term (those that lead to recovery) actions.

In the sections that follow, the plan provides general background information for each sector (H), describes the threats posed by that sector and how it limits recovery, and lists recovery objectives. Actions that have already been implemented and their benefits to VSP parameters of listed populations are identified. Next, the plan describes and prioritizes additional actions that are recommended for recovery of each population. To the extent possible, the recommended actions are tied directly to specific limiting factors, threats, and VSP parameters. Finally, the plan identifies the responsible parties for implementing the actions, how agency coordination will occur, and how implementation will be overseen and achieved.

5.2 Harvest Actions

5.2.1 Background

Fishing has had a significant negative effect on the abundance of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin (see Section 3.4) in the last 150 years. Currently, salmon, steelhead, and bull trout fisheries everywhere are managed with much greater sensitivity to the needs of natural populations, particularly when those populations have been listed under the ESA. Because of the prevalence of listed fish throughout the Columbia Basin, all fisheries in the mainstem Columbia are tightly constrained to limit harvest on listed salmon and steelhead, including Upper Columbia spring Chinook and steelhead. Fisheries in tributaries to the Columbia, including those in the Upper Columbia region, are tightly constrained or, in many cases, closed altogether. For example, there have been no directed fisheries on naturally produced spring Chinook or steelhead in the Upper Columbia Basin for over 20 years. A carefully managed steelhead fishery does occur upstream from Rocky Reach Dam, including the Methow and Okanogan subbasins (but excluding the Entiat). This fishery is directed at surplus hatchery steelhead and is designed to prevent seeding of the habitat with excess numbers of hatchery spawners and increasing the proportion of naturally produced spawners. Ocean catch records (Pacific Fishery Management Council) indicate that virtually no Upper Columbia spring Chinook or steelhead are taken in ocean fisheries. There is a fishery on bull trout in the Lost River in the Methow subbasin.

Fishing seasons for the commercial fisheries in the mainstem Columbia River bordering Washington and Oregon were established by the Columbia River Compact, a bi-state management arrangement approved by Congress in 1918. Recreational fisheries are regulated by the states within their respective boundaries. Tribal ceremonial and subsistence (C&S) fisheries in the mainstem Columbia River and its tributaries are regulated by the Columbia Basin treaty tribes for their respective tribal members. Sharing of the harvest between treaty Indian and non-treaty fisheries follow principles established in ***U.S. v Washington*** and ***U.S. v Oregon*** treaty Indian fishing rights cases. Many of the specific allocation, management and conservation (rebuilding) goals, and production strategies and objectives for the various salmon and steelhead runs are found in stipulated settlement agreements and management plans developed in the ***U.S. v Oregon*** forum. These plans were developed by the treaty tribes, federal government agencies, and states of Washington, Oregon, and Idaho and approved by the federal court, which retains jurisdiction over the case. The Colville Tribes currently regulate fishing by its members within the boundaries of the Colville Reservation and the former north half of the Reservation where reserved tribal fisheries rights exist. Although they are not a party to the ***U.S. v Oregon*** case and do not participate in fisheries in the lower Columbia River, the Colville Tribes clearly have an interest in the status of salmon and steelhead runs in the Upper Columbia River Basin. All harvest plans are evaluated for impacts to listed species in an ESA consultation process prior to implementation of the fishery.

5.2.2 Limiting Factors and Threats

Harvest clearly poses a potential threat to the VSP parameters of naturally produced populations and can be a significant factor that limits recovery. The historical record of salmon fisheries amply demonstrates that excessive harvest over prolonged periods of time can reduce abundance to critical levels, selectively alter the temporal and spatial structure of populations and the size of spawners, and suppress habitat productivity by reducing the flow of essential marine-derived nutrients to freshwater rearing habitats. As described in Section 3.4, salmon throughout the Columbia River Basin share a history of excessive harvests that occurred beginning well over a century ago. Even in recent times, fishery management regimes for mixed stock fisheries, both in the ocean and in the Columbia River mainstem often were based on maximizing the catch of stronger, naturally produced stocks or of hatchery stocks. Catches in mixed stock fisheries often were maintained at high levels by harvest management regimes driven by hatchery stocks produced in large mitigation hatcheries. In combination with non-fishing factors, this pattern contributed ultimately to the listings under the ESA.

Fortunately, the worst harvest management practices of the past have been greatly curtailed or eliminated. As described in Section 5.2.4, below, current management regimes are based to the extent possible on the biological requirements and status of the affected naturally produced stocks. Some listed stocks, however, are still captured incidentally in other fisheries or are harvested by poachers. Some harvest of Upper Columbia spring Chinook and steelhead still occurs in the lower Columbia River in other fisheries. In recent years the harvest of naturally produced Upper Columbia spring Chinook has actually increased because of the larger returns of adults.[86] Harvest rates on naturally produced Upper Columbia steelhead in the lower Columbia River fisheries range up to 3.8%.

Spring Chinook, steelhead, and bull trout are also harvested illegally in their home streams and on their spawning grounds. Bull trout are caught during the sockeye fishery in Lake Wenatchee and during open seasons for mountain whitefish. Additionally, bull trout may be harvested because of misidentification. Currently, there is a fishery on bull trout on the Lost River.

Current threats that reduce the abundance of spawning adult spring Chinook, steelhead, and bull trout include incidental take on directed fisheries and illegal harvest (poaching). The reduction in abundance due to harvest means that a higher productivity is needed to maintain viable populations (see Section 4). However, because harvest is mostly non-selective, historical harvest may have reduced the productivity of naturally produced populations by removing large numbers of naturally produced fish, allowing the natural (or intrinsic) productivity of the population to be reduced by hatchery produced fish spawning in the wild. Population productivity may decrease because hatchery fish spawning in the wild tend to be less productive than the naturally produced fish (Berejikian and Ford 2004).[87] Finally, if populations are critically low in abundance, any harvest could reduce genetic and phenotypic diversity through a phenomenon known as a "population bottleneck."[88]

5.2.3 Harvest Objectives

Harvest objectives for treaty and non-treaty salmon and steelhead fisheries in the Columbia River Basin are set by the applicable state, tribal, and federal agencies. Fishery objectives from McNary Dam to the river mouth (fishing zones 1-6) are established by state, tribal, and federal parties in ***U.S. v Oregon***. In developing management plans under ***U.S. v Oregon***, the parties recognize the necessity of managing the fisheries to provide spawning escapement to the various tributary production areas, including the Upper Columbia tributaries covered in this plan. At the same time, they seek to provide meaningful treaty and non-treaty fishing opportunities in zones 1-6, targeting the more productive natural and hatchery stocks, and, where possible, allow fish to pass through to provide tributary fishing opportunities. Prior to opening fisheries, harvest plans undergo ESA consultation.

The following objectives for harvest apply not only to the Upper Columbia Basin, but also include the entire Columbia River. These objectives are intended to reduce threats associated with harvest.

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[86] Harvest of Upper Columbia spring Chinook in the lower river fisheries has ranged from 5.1% in 1999 (when the ESU was listed) to 14.6% in 2001. During the period 2001-2004, the harvest of Upper Columbia spring Chinook has averaged 12% (Joint Columbia River Management Staff 2005).

[87] The threat of decreased productivity associated with hatchery fish is addressed in Section 5.3 (Hatchery Actions).

[88] A population bottleneck occurs when a population is greatly reduced in size causing rare alleles in the population to be lost. When fewer alleles are present, there is a decline in genetic diversity and the fitness of individuals within the population may decline.

Short-Term Objectives

- Use selective harvest techniques to constrain harvest on naturally produced fish at the currently reduced rates throughout the Columbia Basin.
- Use selective harvest techniques to provide fishery opportunities in the Upper Columbia Basin that focus on hatchery-produced fish that are not needed for recovery.
- Recommend that parties of ***U.S. v Oregon*** incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.
- Increase effective enforcement of fishery rules and regulations.
- Appropriate co-managers/fisheries management agencies should work with local stakeholders to develop tributary fisheries management goals and plans.

Long-Term Objectives

- Provide opportunities for increased tributary harvest consistent with recovery.
- Incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.

Research and Monitoring Objectives

- Research and employ best available technology to reduce incidental mortality of non-target fish in selective fisheries.
- Monitor the effects of incidental take on naturally produced populations in the Upper Columbia Basin.
- Improve estimates of harvested fish and indirect harvest mortalities in freshwater and ocean fisheries.
- Initiate or continue monitoring and research to improve management information, such as the timing of the various run components through the major fisheries.

This plan recognizes that these objectives must balance the conservation of ESA species with the federal government's trust obligations to Native Americans, the priority of tribal reserved rights for fish and fisheries, and the idea that there is an "irreducible core" of tribal harvest that is so vital to the treaty obligation that the federal government will not eliminate it.[89] In addition, this plan integrates efforts from the following harvest programs: Pacific Fishery Management Council (PFMC), which manages Pacific Ocean fisheries in the U.S. south of Canada consistent with sustainable fishing requirements of the U.S. Magnuson-Stevens Act; the Pacific Salmon Commission (PSC), which oversees management by the domestic managers of fisheries subject to a treaty involving Alaska and Canadian fisheries; and the Columbia River mainstem and

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[89] Principle 3(C) of Secretarial Order #3206 Subject: American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act identified five conservation standards that have to be met before tribal harvest can be restricted for ESA purposes. This recovery plan does not attempt to overtop the Secretarial Order.

tributary fisheries, which are regulated by the Columbia River compact (Oregon and Washington concurrent jurisdiction), the Columbia River treaty Indian tribes, the Colville Tribes, and the Washington and Oregon Fish and Wildlife Commissions.

5.2.4 Recent Harvest Actions

For listed Upper Columbia spring Chinook and steelhead, the fisheries can be divided into two geographical categories: those that occur within the Upper Columbia basin, and those that occur outside the basin. Fisheries in both areas undergo ESA consultation prior to opening. Ocean catch records (Pacific Fishery Management Council) indicate that virtually no Upper Columbia spring Chinook or steelhead are taken in ocean fisheries. For upper Columbia spring Chinook and steelhead, most of the out-of-basin harvest occurs downstream in the Columbia River in fisheries managed by the states and tribes pursuant to management plans developed in ***U.S. v Oregon***. The current management plan was recently updated by the parties and covers fisheries for the 2005-2007 seasons. It was adopted by the federal court in May 2005, following a biological opinion issued by NOAA Fisheries Service pursuant to the ESA.

Spring Chinook

Until recently there had been no fisheries directed at spring Chinook since 1977 within the Upper Columbia Basin (other than the fishery downstream from the Leavenworth National Fish Hatchery) or in the Columbia River mainstem. As noted above, almost no Columbia River spring Chinook are taken in ocean fisheries. Only in the last few years have spring Chinook runs increased sufficiently to support limited fisheries directed primarily at hatchery Chinook in the mainstem of the Columbia River. The recent increases in runs are attributed largely to improved ocean conditions and increases in hatchery production, rather than to a major improvement in the general status of the naturally produced populations of spring Chinook.

With virtually no fisheries directed at spring Chinook within the Upper Columbia Basin, the only fisheries that significantly affect Upper Columbia spring Chinook occur downstream, in Zones 1-6 of the lower Columbia River Mainstem. These fisheries occur during what is referred to in ***U.S. v Oregon*** as the winter, spring, and summer seasons, which begin in February and ends July 31 of each year. The treaty fishery occurs exclusively in Zone 6, the area between Bonneville and McNary Dams; the non-treaty commercial fisheries occur in Zones 1-5, which are downstream from Bonneville Dam. The non-treaty recreational (sport) fishery occurs in the mainstem Columbia River from below The Dalles Dam upstream to McNary Dam. All these fisheries were managed subject to the provisions of the Columbia River Fish Management Plan (CRFMP) from 1988 through 1998. The CRFMP was a stipulated agreement adopted by the Federal Court under the continuing jurisdiction of ***U.S. v Oregon***.

Although the CRFMP expired December 31, 1998, it has been extended by court order and agreements. A new three-year (2005-2007) management agreement that covers the remainder of the 2005 winter/spring/summer fishery, as well as the winter/spring/summer and fall season fisheries beginning in 2005 and continuing through December 31, 2007. NOAA Fisheries issued a biological opinion and incidental take statement after finding that the fisheries prescribed by the plan will not jeopardize the survival and recovery of the affected listed species.

The specific spring Chinook harvest rate schedule developed for the 2001-2005 plan scales the allowable harvest rate to the relative abundance of the runs of interest, in this case the listed

Upriver Columbia spring Chinook and Snake River spring/summer Chinook. As noted above, the 1988-98 CRFMP limited the treaty Indian fishery impacts at 5-7% and the non-treaty impacts at 5% of the aggregate run (hatchery plus natural) of all upriver spring Chinook (and spring/summer Chinook) at all run sizes up to a certain point (which was never reached while it was in place). It would have then allowed the harvest of 100% of the fish above that point. This relatively simple formulation implies that all natural spawners up to a certain level (the escapement goal) are equally important, and above that level have no value at all. The more recent agreements, developed in the context of a mixture of much larger, mostly hatchery runs and depressed ESA-listed runs, allow somewhat higher impacts on naturally produced fish in times of greater overall abundance, but prescribe fewer impacts when abundance declines to lower levels (relative to the 1988-98 CRFMP). Notably, the new harvest rate schedule limits impacts on naturally produced Upper Columbia River spring Chinook when their forecast abundance falls below a pre-defined critical level of 1,000 naturally produced Upper Columbia spring Chinook.[90]

The logic underlying this approach recognizes the increasingly higher biological value of naturally produced spawners as their number decreases. It also recognizes the continued added value of additional spawners even when the abundance of natural spawners increases above what formerly was the spawning escapement goal. Two of the simplifying assumptions underlying the harvest-rate schedule is that each of the Upper Columbia spring Chinook populations are affected at the same rates in the mainstem fisheries, and the abundances of all spring Chinook populations (hatchery and natural) co-vary from year to year (i.e., rise and fall in abundance at more or less the same rate). No Upper Columbia population-specific run timing data currently exist to determine the feasibility of shaping mainstem fisheries (temporally or geographically) to target or avoid specific natural populations passing through the fisheries. Similarly, there is insufficient data currently available to determine whether the several natural populations or the natural and hatchery populations co-vary. Whether these assumptions prove to be a problem in terms of achieving population-specific escapement objectives with the current harvest rate schedule will have to be determined through monitoring.

Because spring Chinook returns in recent years (since 2000, but before 2005) have been quite high relative to the recent past, the result of the new harvest rate schedule so far has been a higher average impact rate. However, if the run sizes drop to levels typical of the two decades before 2000, impact rates will be reduced.

A recent change in Columbia River fisheries management has been the emergence of “mark selectivity.” Currently, almost all salmon and steelhead produced in hatcheries and intended for harvest are mass marked by removing the adipose fin on each fish, by federal law. Marking of hatchery fish enables biologists to distinguish between hatchery and naturally produced fish in the escapements, thereby improving assessments of the status of natural populations. It also enables harvest managers to use mark-selective fishery regulations to target fisheries on returning hatchery fish that are surplus to escapement needs. Limited currently to impacts of 2% or less (depending on the annual run size) of listed upriver spring Chinook, the states

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[90] The critical level of 1000 fish is inconsistent with the recovery criterion of 4500 fish (see Section 4.4). The UCSRB is concerned that such management actions implemented in the lower Columbia will hinder recovery of Upper Columbia stocks.

(Washington and Oregon) now require non-treaty commercial net and recreational fisheries to release alive all unmarked spring Chinook and steelhead caught in their lower Columbia River spring fisheries.[91] This has required the commercial fishery to switch from gill nets to "tangle nets," which, when operated properly, make it possible for the catch to be sorted while still alive and the unmarked fish to be released.

A portion of the fish caught and released from tangle nets and recreational hook-and-line gear will die. These mortalities are included in the 2% impact limit. The catch-and-release mortality rate varies for different gear types, different species, and different fishing conditions, and those values are often unknown. Catch-and-release mortality rates have been estimated from available data and are applied by the ***U.S. v Oregon*** Technical Advisory Committee (TAC) during the management of the fisheries. The TAC applies a 10% incidental mortality rate to salmon caught and released during recreational fishing activities. The TAC also applies a 1% incidental mortality rate to salmon caught and released using dipnets (although these typically are not managed to be mark-selective). Catch-and-release mortality associated with selective tangle net and gillnet fisheries during the winter and spring season are 18.5% and 30%, respectively. Estimates of catch-and-release mortality are combined with landed catch estimates when reporting the expected total mortality, and are therefore specifically accounted for in the harvest rate schedule and the biological opinion. By requiring the release of unmarked fish and allowing retention of only the marked hatchery fish, the states have been able to provide a much larger total catch to these fisheries than would be the case if the fisheries were managed to be non-selective.

Another harvest management change incorporated into the 2005-2007 ***U.S. v Oregon*** involves a revision in the dates delineating the "spring season" management period from the "summer season" management period for the mainstem Columbia River fisheries. Under the 2001-2005 Interim Management Agreement and previous agreements, the Snake River and upriver spring Chinook (which include Upper Columbia spring Chinook), and the Snake River and upriver summer Chinook were managed as separate units during the spring and summer management periods. Analysis of the run timing of spring and Snake River spring/summer Chinook indicated that 96% of upriver spring and Snake River spring/summer Chinook passed Bonneville Dam by June 15. In other words, the timing of Snake River summer Chinook is better grouped with the other spring-run fish, including the Upper Columbia spring Chinook. TAC therefore proposed modifying the spring and summer management periods so that Snake River spring/summer Chinook could be included in the spring management period. TAC proposed changing the spring management period from an end date of May 31, to an end date of June 15. By adjusting the spring/summer separation date to June 15 to better reflect the run-timing of listed summer populations of the Snake River spring/summer-run Chinook ESU, there is additional fishing opportunity on unlisted upriver summer Chinook, which apparently have later timing and can be targeted in summer season fisheries.

The current agreement includes a modified harvest rate schedule for the spring management period. The intent underlying development of the modified harvest rate schedule was to maintain harvest rates consistent with the 2001-2005 Interim Management Agreement, while accounting

[91] Some of the non-treaty fisheries in the lower river are not mark selective.

for the adjusted management period. This was done by adjusting the “breakpoints” in the harvest rate schedule by approximately 8%, which accounts for the average percent of the run passing Bonneville Dam in the June 1-15 timeframe. Because including additional days in the management period will mean larger dam counts and thus larger run sizes, it was necessary to raise the harvest breakpoints by an appropriate amount to maintain constant relative harvest rates between the two management systems (i.e., the 2001-2005 plan and the 2005-2007 plan). By making this change in the management framework, and managing Snake River spring/summer Chinook together, run reconstructions should be more accurate, leading to improved assessment of stock status and more accurate measurements of impacts on listed fish.

Steelhead

Recent changes in fishery management to protect steelhead have substantially reduced harvest risks to naturally produced steelhead populations in the Upper Columbia Basin. Harvest rates of steelhead in the lower Columbia River fisheries (both tribal and non-tribal) are generally less than 5-10% (NMFS 2001, NOAA Fisheries 2004). NOAA Fisheries does not consider harvesting hatchery steelhead at a higher rate than naturally produced steelhead a risk to the species. In fact, in the Upper Columbia Basin, harvest is used as a management tool to reduce the uncertain effects of hatchery steelhead spawning with naturally produced steelhead (NMFS 2003; Berejikian and Ford 2004). The linking of harvest with hatchery operations in a single plan is a relatively new approach to hatchery implementation.

WDFW regulates the harvest of hatchery steelhead in the Upper Columbia Basin. There is no directed fishery on naturally produced steelhead in the basin. NOAA Fisheries (2003) approved a tiered-approach to the harvest of hatchery steelhead via an ESA consultation and permit issuance. The goal of the fishery is to reduce the number of hatchery steelhead that exceed habitat seeding levels in spawning areas and to increase the proportion of naturally produced steelhead in the spawning populations. To this end, WDFW may either remove hatchery steelhead at dams or other trapping sites, or they may use recreational fisheries to selectively harvest hatchery steelhead (adipose fin-clipped fish). Under the current ESA permit, steelhead fisheries on adipose fin-clipped hatchery steelhead may be implemented in the Wenatchee, Methow, and/or Okanogan basin when naturally produced steelhead run levels meet define criteria. The current permit criteria (NMFS 2003) are:

- When the natural origin (wild) steelhead run is predicted to exceed 1,300 fish at Priest Rapids Dam and the total steelhead run is predicted to exceed 9,550 steelhead, a harvest fishery may be considered as an option to remove excess adipose fin-clipped hatchery steelhead. For a fishery to be authorized in the tributary areas, the predicted tributary escapements must meet certain minimum tier 1 criteria (**Table 5.1**; Tier 1). The mortality impact on naturally produced steelhead must not exceed the specified limits for Tier 1 in each tributary area.

- When the natural origin steelhead run is predicted to exceed 2,500 fish at Priest Rapids Dam, and the total steelhead run is predicted to exceed 10,035 steelhead, and the tributary escapements meet the minimum targets, then naturally produced steelhead mortality impacts must not exceed the limits specified for Tier 2 in each tributary area (**Table 5.1**; Tier 2).

- When the natural origin steelhead run is predicted to exceed 3,500 fish at Priest Rapids Dam, and the total steelhead run is predicted to exceed 20,000 steelhead, and the tributary escapements meet the minimum targets, then naturally produced steelhead mortality impacts must not exceed the limits specified for Tier 3 in each tributary area (**Table 5.1**; Tier 3).

- The WDFW may remove artificially propagated steelhead at dams or other trapping sites to reduce the number of artificially propagated steelhead in the spawning areas in excess of full habitat seeding levels to increase the proportion of naturally produced steelhead in the spawning population.

Bull Trout

WDFW regulates the harvest of bull trout in the Upper Columbia Basin. Except for a fishery in the Lost River, there has been no directed fishery on bull trout in the Upper Columbia Basin since the listing of bull trout in 1998. These changes have substantially reduced legal harvest of Upper Columbia bull trout. The reduced steelhead fishery likely also benefited bull trout through reduced incidental catch of bull trout.

5.2.5 Harvest Recovery Actions

Recovery actions listed below for each population are intended to reduce threats associated with harvest, which is limited to impacts on naturally produced populations that are incidental to fisheries directed at hatchery fish or other species. This plan strengthens the likelihood that all actions and mitigation associated with harvest throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout. These actions primarily address adult abundance.

Spring Chinook

Wenatchee Population

Currently, non-listed, hatchery-produced spring Chinook salmon are harvested in Icicle Creek, downstream from the Leavenworth NFH. A fishery in the Wenatchee River has not been open since the ESA listing in 1999 to protect commingled naturally produced spring Chinook in the area.

Short-term Actions

- Continue the current fishery in Icicle Creek on non-listed, hatchery produced spring Chinook when estimated hatchery adult returns exceed hatchery needs.

- Maintain a closed fishery on naturally produced spring Chinook in the Wenatchee River until naturally produced fish meet “recovery” abundance, productivity, and spatial structure/diversity criteria (2,000 naturally produced adults and spawner:spawner ratios greater than 1).

- Develop a limited fishery on surplus hatchery produced spring Chinook in the Wenatchee subbasin.

- Increase enforcement efforts to reduce poaching of spring Chinook salmon in the Wenatchee subbasin.

- Strive to make that all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Continue the fishery in Icicle Creek on hatchery-produced fish when the estimated hatchery adult returns exceed hatchery needs.
- Open a fishery on naturally produced spring Chinook on the Wenatchee River after naturally produced fish meet "recovery" abundance, productivity, and spatial structure/diversity criteria (2,000 naturally produced adults and spawner:spawner ratios greater than 1).
- In cooperation with parties of ***U.S. v Oregon***, incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing and promote the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Monitor the effects of the Icicle fishery on the abundance of naturally produced spring Chinook in the Wenatchee population.
- Once a fishery on naturally produced spring Chinook opens, monitor the effects of harvest on the abundance of spring Chinook in the Wenatchee subbasin.
- Monitor the effects of incidental take of other listed and sensitive species during a spring Chinook fishery.
- Monitor the effects of any current or future hatchery fishery on naturally produced fish.

Entiat Population

Before spring Chinook were listing as endangered in 1999, WDFW opened a fishery in the Entiat only when the adult returns were high. Since the ESA listing, there has been no fishery in the Entiat River.

Short-term Actions

- Maintain a closed fishery on naturally produced spring Chinook on the Entiat River until naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).
- Develop a limited fishery on surplus hatchery produced spring Chinook in the Entiat subbasin.
- Increase enforcement efforts to reduce poaching of spring Chinook salmon in the Entiat subbasin.

- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced spring Chinook on the Entiat River after naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).
- In cooperation with parties of ***U.S. v Oregon***, incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Once a fishery on naturally produced spring Chinook opens, monitor the effects of harvest on the abundance of spring Chinook in the Entiat subbasin.
- Monitor the effects of incidental take of other listed and sensitive species during a spring Chinook fishery.
- Monitor the effects of any current or future hatchery fishery on naturally produced fish.

Methow Population

There has been no fishery for spring Chinook in the Methow subbasin for several decades.

Short-term Actions

- Maintain a closed fishery on naturally produced spring Chinook on the Methow River until naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (2,000 naturally produced adults and spawner:spawner ratios greater than 1).
- Develop a limited fishery on surplus hatchery produced spring Chinook in the Methow subbasin.
- Increase enforcement efforts to reduce poaching of spring Chinook salmon in the Methow subbasin.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced spring Chinook in the Methow River after naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (2,000 naturally produced adults and spawner:spawner ratios greater than 1).

- In cooperation with parties of ***U.S. v Oregon***, incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Once a fishery on naturally produced spring Chinook opens, monitor the effects of harvest on the abundance of spring Chinook in the Methow subbasin.
- Monitor the effects of incidental take of other listed and sensitive species during a spring Chinook fishery.
- Monitor the effects of any current or future hatchery fishery on naturally produced fish.

Upper Columbia River

Currently, the abundance of naturally produced Upper Columbia spring Chinook is too low to support a fishery.

Short-term Actions

- Maintain a closed salmonid fishery on the upper mainstem Columbia River downstream from the mouth of the Okanogan River until July when it opens for summer Chinook salmon.
- Develop a fishery on hatchery-produced spring Chinook upstream from the mouth of the Okanogan River.
- Work with parties in ***U.S. v. Oregon*** to reduce the harvest or incidental take of Upper Columbia spring Chinook in the lower Columbia River fisheries.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on the mainstem Upper Columbia River after naturally produced spring Chinook within each population meet “recovery” abundance, productivity, and spatial/diversity criteria.
- In cooperation with parties of ***U.S. v Oregon***, incorporate Upper Columbia VSP criteria when formulating fishery plans affecting Upper Columbia spring Chinook.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Develop gear and handling techniques, as well as regulatory options in both commercial and sport fisheries, to minimize selective fishery impacts to naturally produced Upper Columbia spring Chinook.
- Develop or improve monitoring tools to evaluate fishery catch to assure impacts to naturally produced Upper Columbia spring Chinook are maintained within the take limits.
- Monitor lower Columbia River selective fisheries and estimate impacts to naturally produced Upper Columbia spring Chinook.
- Estimate handling mortality of released naturally produced Upper Columbia spring Chinook in the lower Columbia River fishery.
- Monitor the effects of incidental take on other listed and sensitive species during a spring Chinook fishery.

Steelhead

Wenatchee Population

Before the listing of steelhead as endangered in 1997, the Wenatchee River supported a fairly robust sport fishery. There is currently no harvest of steelhead in the Wenatchee subbasin.

Short-term Actions

- Maintain a no-harvest fishery on naturally produced steelhead in the Wenatchee subbasin until naturally produced fish meet “recovery” abundance, productivity, and spatial/diversity criteria (1,000 naturally produced adults and spawner:spawner ratios greater than 1).
- Develop a limited fishery on surplus hatchery produced steelhead in the Wenatchee subbasin.
- Maintain ban on planting hatchery produced “catchable” rainbow trout into steelhead habitat in the Wenatchee subbasin.
- Increase enforcement efforts to reduce poaching of steelhead in the Wenatchee subbasin.
- Strive to make actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced steelhead in the Wenatchee subbasin after naturally produced fish meet “recovery” abundance, productivity, spatial/diversity criteria (1,000 naturally produced adults and spawner:spawner ratios greater than 1).
- Strive to make actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- After steelhead are reclassified as "threatened," examine the effects of an experimental catch-and-release fishery on the survival of naturally produced adult steelhead in the Wenatchee River.
- Assess the population structure of ***O. mykiss*** (resident and anadromous).
- Once a fishery on naturally produced steelhead opens, monitor the effects of harvest on the abundance of steelhead in the Wenatchee subbasin.
- Monitor the effects of incidental take on other listed and sensitive species during a steelhead fishery.
- Monitor the effects of incidental take of steelhead during the whitefish fishery.

Entiat Population

Before steelhead were listed as endangered in 1997, WDFW opened a small fishery in the Entiat. Since the ESA listing, there has been no steelhead fishery in the Entiat River.

Short-term Actions

- Maintain a no-harvest fishery on naturally produced steelhead in the Entiat subbasin until naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).
- Develop a limited fishery on wandering/straying hatchery produced steelhead in the Entiat subbasin.
- Maintain ban on planting hatchery produced "catchable" rainbow trout into steelhead habitat in the Entiat subbasin.
- Increase enforcement efforts to reduce poaching of steelhead in the Entiat subbasin.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced steelhead in the Entiat subbasin after naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- After steelhead are reclassified as "threatened," examine the effects of an experimental catch-and-release fishery on the survival of naturally produced adult steelhead in the Entiat River.

- Once a fishery on naturally produced steelhead opens, monitor the effects of harvest on the abundance of steelhead in the Entiat subbasin.
- Assess the population structure of ***O. mykiss*** (resident and anadromous).
- Examine the effects of out-of-basin hatchery steelhead on the Entiat population
- Monitor the effects of incidental take on other listed and sensitive species during a steelhead fishery.
- Monitor the effects of incidental take of steelhead during the whitefish fishery.

Methow Population

Before the ESA listing, the Methow River was a major steelhead fishery (Mullan et al. 1992; Chapman et al. 1994). There is currently a fishery on hatchery produced steelhead in the Methow River. This fishery is intended to reduce the number of hatchery produced fish that spawn with naturally produced fish.

Short-term Actions

- Maintain the current fishery on hatchery produced steelhead in the Methow River. The fishery shall follow the tiered approach developed by WDFW and NOAA Fisheries as outlined in **Table 5.1**.
- Allow no harvest on naturally produced steelhead in the Methow subbasin until naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (1,000 naturally produced adults and spawner:spawner ratios greater than 1).
- Maintain ban on planting hatchery produced "catchable" rainbow trout into steelhead habitat in the Methow subbasin.
- Increase enforcement efforts to reduce poaching of steelhead in the Methow subbasin.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.
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Long-term Actions

- Open a fishery on naturally produced steelhead in the Methow subbasin after naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (1,000 naturally produced adults and spawner:spawner ratios greater than 1).
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Examine the effects of the current fishery on the survival and abundance of naturally produced adult steelhead in the Methow River.
- Once a fishery on naturally produced steelhead opens, monitor the effects of harvest on the abundance of steelhead in the Methow subbasin.
- Assess the population structure of ***O. mykiss*** (resident and anadromous).
- Monitor the effects of incidental take on other listed and sensitive species during a steelhead fishery.
- Monitor the effects of incidental take of steelhead during the whitefish fishery.

Okanogan Population

There is currently a fishery on hatchery-produced steelhead in the Okanogan River. This fishery is intended to reduce the number of hatchery-produced fish that spawn with naturally produced fish.

Short-term Actions

- Continue the current fishery on hatchery produced steelhead following the Tiered approach outlined in **Table 5.1**.[92]
- Allow no harvest of naturally produced steelhead in the Okanogan subbasin until naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).
- Ban plantings of hatchery produced "catchable" rainbow trout into steelhead habitat in the Okanogan subbasin.
- Increase enforcement efforts to reduce poaching of steelhead in the Okanogan subbasin.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced steelhead in the Okanogan subbasin after naturally produced fish meet "recovery" abundance, productivity, and spatial/diversity criteria (500 naturally produced adults and spawner:spawner ratios greater than 1).

[92] The current steelhead fishery in the Okanogan River does not allow the Colville Tribes to exercise their reserved fishery right. The Colville Tribes intend to seek a modification to their NOAA consultation on steelhead harvest to ensure the opportunity to exercise their reserved fishery right. Provided the tribal fishery targets hatchery produced steelhead, this action will not preclude recovery of steelhead in the Okanogan subbasin.

- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Examine the effects of the current fishery on the survival and abundance of naturally produced adult steelhead in the Okanogan subbasin.
- Once a fishery on naturally produced steelhead opens, monitor the effects of harvest on the abundance of steelhead in the Okanogan subbasin.
- Assess the population structure of ***O. mykiss*** (resident and anadromous).
- Monitor the effects of incidental take on other listed and sensitive species during a steelhead fishery.
- Monitor the effects of incidental take of steelhead during the whitefish fishery.

Upper Columbia River

Currently, the abundance of naturally produced Upper Columbia steelhead is too low to support a fishery.

Short-term Actions

- Maintain fishery on hatchery-produced steelhead in the mainstem Upper Columbia River.
- Allow no harvest of naturally produced steelhead in the mainstem Upper Columbia River.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery on naturally produced Upper Columbia steelhead in the mainstem Upper Columbia River after naturally produced fish within each population meet “recovery” abundance, productivity, and spatial/diversity criteria.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Develop gear and handling techniques, as well as regulatory options in both commercial and sport fisheries, to minimize selective fishery impacts to naturally produced Upper Columbia steelhead.
- Develop or improve monitoring tools to evaluate fishery catch to assure impacts to naturally produced steelhead are maintained within the limits.

- Monitor Columbia River selective fisheries and estimate impacts to naturally produced Upper Columbia steelhead.
- Estimate handling mortality of released naturally produced Upper Columbia steelhead in the Columbia River fishery.
- Monitor the effects of incidental take on other listed and sensitive species during a steelhead fishery.

Bull Trout

Wenatchee Core Area

There has been no fishing for bull trout in the Wenatchee Core Area since the listing of bull trout as threatened in 1998.

Short-term Actions

- Maintain a closed fishery on bull trout in the Wenatchee Core Area until bull trout meet "recovery" abundance and productivity criteria (1,612 adult bull trout and a stable or increasing trend).
- Maintain ban on planting hatchery produced "catchable" rainbow trout into bull trout streams in the Wenatchee Core Area to reduce the probability of incidental harvest of bull trout
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Increase fisherman education during the sockeye salmon fishery in Lake Wenatchee.
- Increase enforcement efforts to reduce poaching of bull trout in the Wenatchee Core Area.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery in the Wenatchee Core Area after bull trout meet "recovery" abundance and productivity criteria (1,612 adults and a stable or increasing trend).
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Examine the effects of an experimental catch-and-release fishery on the survival of adult bull trout in the Wenatchee Core Area once bull trout reach "recovery" criteria.
- Examine the effects of the mainstem bait fishery on bull trout.

- Monitor the incidental catch of bull trout in the Lake Wenatchee sockeye fishery and in the whitefish fishery.
- Once a fishery on bull trout opens, monitor the effects of harvest on the abundance of bull trout in the Wenatchee Core Area.
- Monitor the effects of incidental take on other listed and sensitive species during a bull trout fishery.

Entiat Core Area

There has been no fishing for bull trout in the Entiat Core Area since the listing of bull trout as threatened in 1998.

Short-term Actions

- Maintain a closed fishery on bull trout in the Entiat Core Area until bull trout meet "recovery" abundance and productivity criteria (298 adult bull trout and a stable or increasing trend).
- Maintain ban on planting hatchery produced "catchable" rainbow trout into bull trout streams in the Entiat Core Area to reduce the probability of incidental harvest of bull trout.
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Increase enforcement efforts to reduce poaching of bull trout in the Entiat Core Area.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery in the Entiat Core Area after bull trout meet "recovery" abundance and productivity criteria (298 adults and a stable or increasing trend).
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Examine the effects of an experimental catch-and-release fishery on the survival of adult bull trout in the Entiat Core Area once bull trout reach "recovery" criteria.
- Monitor the incidental catch of bull trout in the whitefish fishery on the Entiat Core Area.
- Once a fishery on bull trout opens, monitor the effects of harvest on the abundance of bull trout in the Entiat Core Area.

- Monitor the effects of incidental take on other listed and sensitive species during a bull trout fishery.

Methow Core Area

Except for a small fishery in the Lost River watershed, there has been no fishing for bull trout in the Methow Core Area since the listing of bull trout as threatened in 1998.

Short-term Actions

- Maintain ban on planting hatchery produced "catchable" rainbow trout into bull trout streams in the Methow Core Area to reduce the probability of incidental harvest of bull trout.
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Increase enforcement efforts to reduce poaching of bull trout in the Methow Core Area.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Long-term Actions

- Open a fishery in the Methow Core Area after bull trout meet "recovery" abundance and productivity criteria (1,234 adults and a stable or increasing trend).
- Ban all plantings of brook trout within waters associated with or connected to bull trout habitat.
- Strive to make all actions and mitigation associated with harvest throughout the Columbia River, identified through ESA Consultation, consistent with advancing the recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Research and Monitoring Actions

- Examine the effects of an experimental catch-and-release fishery on the survival of adult bull trout in the Methow Core Area once bull trout reach "recovery" criteria.
- Monitor and evaluate the fishery in the Upper Lost River.
- Monitor the incidental catch of bull trout in the steelhead and whitefish fisheries on the Methow Core Area.
- Once a fishery on bull trout opens, monitor the effects of harvest on the abundance of bull trout in the Methow Core Area.
- Monitor the effects of incidental take on other listed and sensitive species during a bull trout fishery.

5.2.6 Responsible Parties

WDFW, the Yakama Nation, and the Colville Tribes are responsible for managing, regulating, enforcing, and monitoring their respective fisheries within the Upper Columbia River Basin.

NOAA Fisheries and the USFWS are responsible for administering the requirements of the ESA on salmon and steelhead, and bull trout, respectively, which includes issuing biological opinions, approving management plans, and specifying allowable levels of take in fisheries. WDFW has authority within the State of Washington to enforce regulations pertaining to any fishery, while tribes regulate fisheries on tribal lands.

5.2.7 Coordination and Commitments

This plan assumes that an Implementation Team, made up of representatives from various federal and state agencies, tribes, counties, and stakeholders will engage in discussions associated with harvest actions. This team will be involved in all issues related to harvest policies and recovery actions. Harvest actions outside the Upper Columbia Basin will continue to fall under the purview of the parties pursuant to the ongoing ***U.S. v Oregon*** litigation. If necessary, the Implementation Team may establish a technical committee made up of harvest managers and scientists to provide technical advice to the Implementation Team, review monitoring and research actions associated with harvest, and identify gaps and additional research needs. To the extent possible, existing entities (WDFW, tribal fisheries staff, the ***U.S. v Oregon*** Technical Advisory Committee, and federal agencies) should be relied upon to provide scientific and technical advice regarding harvest and its impacts. The Implementation Team will work with parties in ***U.S. v. Oregon*** to coordinate any harvest actions implemented within the Columbia River fishery with other harvest plans affecting Upper Columbia populations.

5.2.8 Compliance

For harvest regulations to achieve their objectives, it is important that monitoring and evaluation occur in places where actions are targeted. The federal and state agencies and the tribes are responsible for monitoring harvest in the Upper Columbia Basin. In the steelhead fishery, WDFW monitors the total take of steelhead and person-days to determine when the allowable "take" is met (this is based on catch rate, the presumed naturally produced component, and post-release mortality). The fishery is closed after the calculated take is reached.

The Icicle fishery is the only fishery targeting spring Chinook in the Upper Columbia Basin. This fishery targets non-listed, hatchery produced spring Chinook. It opens only after it is estimated that the run size exceeds the needs of the Leavenworth NFH. WDFW and the USFWS monitor the catch and extract biological information on fish caught.

Additional effort is needed to monitor the illegal capture of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. This effort is necessary to better understand the fraction of the adult population harvested illegally. This effort will likely require additional conservation enforcement officers.

5.3 Hatchery Actions

5.3.1 Background

Hatcheries in the Upper Columbia Basin began operations as early as the late 1800s. The first hatcheries that released spring Chinook in the Upper Columbia Basin began operation in 1899 on the Wenatchee River (Chiwaukum Creek) and near the confluence of the Twisp River on the Methow River. These hatcheries, operated by Washington Department of Fish and Game, were built to replenish salmon (primarily Chinook and coho) runs that had virtually been eliminated by the 1890's. Craig and Suomela (1941) commented:

> It appears evident that the Washington State fisheries authorities have from time to time made attempts to introduce exotic populations of salmon to the Wenatchee River...and that they carried on this program from many years before the Grand Coulee fish salvage activities made necessary the transfer of strange runs of fish to that river.

The Leavenworth National Fish Hatchery Complex was constructed between 1938 and 1940. The Complex consists of three large hatchery facilities, Leavenworth National Fish Hatchery (LNFH), Entiat National Fish Hatchery (ENFH), and Winthrop National Fish Hatchery (WNFH), which are operated by the USFWS. They were constructed as mitigation facilities to compensate for the loss of spawning and rearing habitat caused by the construction of Grand Coulee Dam. The facility planned for the Okanogan River was never constructed. These programs were authorized as part of the Grand Coulee Fish Maintenance Project (GCFMP) on April 3, 1937, and reauthorized by the Mitchell Act (52 Stat. 345) on May 11, 1938. Both the Entiat and Leavenworth facilities currently produce non-listed, out-of-basin spring Chinook. The Winthrop National Fish Hatchery produces listed spring Chinook and steelhead.

The WDFW began continuous artificial propagation of summer Chinook and steelhead in the Upper Columbia River basin in the 1960’s at Wells (Douglas PUD) and Chelan Hatcheries (construction of Rocky Reach; Chelan PUD). These early propagation programs were intended to provide fish mainly for harvest; ecological consequences of these programs were not a high priority. In 1989, new artificial propagation programs were funded by Chelan PUD as mitigation for Rock Island Dam. In 1991, Douglas PUD began funding artificial propagation programs of spring Chinook salmon in the Methow basin as mitigation for Wells Dam.

In 2004, HCP agreements among Chelan PUD, Douglas PUD, NOAA Fisheries, USFWS, WDFW, the Colville Tribes, and the Yakama Nation formalized funding and actions setting the stage for continued operation of both the hatchery programs initiated in the 1960’s and the relatively newer programs started in 1989 and 1991. Among the mechanisms for change defined in the HCPs was the creation of Hatchery Committees (one for each HCP) that were tasked with oversight of the artificial propagation programs. A settlement agreement with Grant PUD has proposed additional artificial propagation within the Upper Columbia Basin.[93]

Current artificial propagation programs operated by the Colville Tribes include a spring Chinook and steelhead program as well as plans for a summer Chinook program. Spring Chinook were provided from Leavenworth National Fish Hatchery and acclimated and released in the Okanogan subbasin as an interim, isolated harvest program to support tribal ceremonial and subsistence fishing and provide information for a proposed long-term integrated recovery program. Steelhead are propagated and released in the Okanogan subbasin as an integrated

[93] It is important to note that the HCPs and Grant Settlement Agreement call for robust monitoring and evaluation plans to answer some of the outstanding scientific questions concerning hatchery programs and their affect on naturally reproducing populations. These M&E Plans test hypotheses concerning questions like the relative reproductive success of natural spawning hatchery descendents, effects on productivity, and others. The use of a reference condition is paramount in understanding these potential effects.

harvest program. The tribes have initiated a local broodstock program and will be starting a kelt reconditioning program to create a comprehensive integrated recovery program for steelhead.

Other species, such as sockeye, summer Chinook, and coho salmon are produced within state and/or federal facilities. In the Wenatchee subbasin, summer Chinook and sockeye are produced in facilities operated by WDFW, while coho salmon are reared at the Leavenworth National Fish Hatchery for the Yakama Nation to assess the feasibility of reintroducing coho into the Upper Columbia Basin. In the Methow subbasin, a state-operated facility produces summer Chinook, while Winthrop National Fish Hatchery rears coho salmon for the Yakama Nation. In the Okanogan subbasin, summer Chinook are produced at the state-operated facility[94] and sockeye in various Canadian facilities.

Current Hatchery Operations

As of 2005, the Upper Columbia Basin has seven large hatchery facilities and twelve smaller rearing or acclimation facilities (**Table 5.2**). In sum, these facilities, operated by state, tribal, and federal entities, include about 22 artificial propagation programs in the Upper Columbia Basin. What follows is a description of the current status of these programs and an assessment of their effects on listed populations and ESUs. The assessment of each artificial propagation program and their relationship to the ESUs was conducted by NMFS (2004). It is important to note that the majority of the hatchery programs in the Upper Columbia Basin were developed to mitigate for fish losses at dams. Additionally, hatchery programs undergo ESA consultation to maintain consistency with the recovery of ESA-listed species.

Wenatchee Subbasin

The Wenatchee spring Chinook population is affected by several artificial propagation programs that release spring Chinook within the Wenatchee subbasin. The Chiwawa River and White River are integrated with the local population and are included in the ESU. The LNFH spring Chinook program releases an out-of-basin stock that is not included in the ESU because their origin is a mixture of Upper Columbia and Snake River spring Chinook stocks captured at Bonneville Dam during the period 1955 through 1964 (Waples et al. 2004; Campton, in press).

Chiwawa River Spring Chinook Program

Artificial propagation of Chiwawa River spring Chinook began in 1989 as mitigation for Rock Island Dam. The program is guided by a committee with representatives from co-managers and the funding entity (CPUD 2002). A comprehensive monitoring and evaluation plan consistent with recommendations from the Independent Scientific Advisory Board is in place to guide the operation of the program. The goal developed by the HCP Hatchery Committee is:

> recovery of ESA listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

[94] The Colville Tribes have proposed to expand the conservation aspects of this program to increase the abundance, productivity, and diversity of summer Chinook in the Okanogan subbasin.

The program was initiated as an integrated supplementation program using locally derived spring Chinook returning to the Chiwawa River. Since the mid-1990s, when adult runs were at record low numbers, some hatchery produced Chinook returning from this program were collected for broodstock. However, a minimum of 30% of the annual broodstock has remained naturally produced fish. The Chiwawa River is the only source for natural origin broodstock. A weir is used to collect adult broodstock from the Chiwawa River. Spring Chinook not collected for broodstock are released unharmed upstream of the weir. Tumwater Dam on the Wenatchee River is used to collect returning hatchery produced fish for broodstock. Before gametes from fish collected at Tumwater Dam are incorporated into the program, coded-wire tags are extracted and read to allow only fish from the Chiwawa Program to be used.

Monitoring of this program includes periodic genetic analysis of hatchery and naturally produced fish. Based only on first-year adult returns, naturally and hatchery produced fish were genetically similar (Ford et al. 2001). The life-history characteristics of run timing and spawn timing were also similar. However, differences exist in age-at-return (Tonseth et al. 2002). Fifty-six percent of the naturally produced fish return at age five; only 15% of the hatchery fish return at age five. The fecundity (eggs per female) of these hatchery fish is less than the naturally produced fish as a result of the younger age at return.

The program is intended to increase the number of adults on the spawning grounds and subsequently lead to an increase in natural production. Releases have averaged from zero fish in 1995 and in 1999 to about 364,000 yearling Chinook salmon smolts out of a target production level of 672,000. However, co-managers agree that 672,000 smolts likely exceed the biological capacity of the basin (BAMP 1998). Reduction in the production level is being contemplated within the appropriate forums. A new program is being initiated in Nason Creek, as part of the Priest Rapids Settlement Agreement that coupled with a reduction of the Chiwawa program production level would balance supplementation levels with habitat capacity. External marking of smolts released by removal of the adipose fin has occurred in most, but not all years. All release groups have been 100% coded-wire tagged.

The performance of the program is assessed through a monitoring and evaluation program that includes both within hatchery monitoring and natural environment monitoring. With respect to recovery of natural populations, the natural environmental monitoring will likely provide more insight on the impacts of the hatchery program on the natural population. Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed an average of 44% of the natural spawning population from 1993 through 2003. Smolt release to adult return has averaged 0.42% (1993-2003 returns). These data suggest that the program has increased the number of spawners and that hatchery produced spawners may have commingled with naturally produced adults on the spawning grounds. An average 28% of the returning Chiwawa-program adults have strayed to other Wenatchee River tributaries (Nason Creek, White River, Little Wenatchee River, and Icicle Creek) and to areas outside the Wenatchee River subbasin including the Entiat and Methow rivers (Miller 2003; Tonseth 2003, 2004; Hamstreet and Carie 2003). Straying may be related to the rearing facility switching to Wenatchee River water during periods when ice precludes the use of Chiwawa River water.

Juvenile emigrant trapping and snorkeling is conducted to assess productivity of natural spawners. Juvenile emigration data indicate that hatchery produced fish are successfully producing juveniles (Miller 2003). Smolt-to-adult survival of hatchery fish is low compared to naturally produced fish (0.42% for hatchery fish compared to 0.63% for naturally produced fish for 1993-2000 broods). The sustained productivity of hatchery fish over several generations in the natural environment has not been demonstrated.

The Chiwawa spring Chinook salmon program has returned adult salmon to the spawning grounds since 1993. These fish appear to have successfully reproduced and may have increased the abundance of naturally produced Chinook in the population. The productivity of hatchery-produced fish relative to naturally produced fish in the natural environment is unknown. The program operates to preserve genetic diversity by incorporating naturally produced Chinook into the broodstock annually. The program does not appear to have altered the spatial distribution of the population. If the program releases the full production level of 672,000 smolts annually, the risk of impacts on productivity and diversity will increase (BAMP 1998). The effects of Chiwawa strays within and out of the Wenatchee Basin need to be addressed because this factor decreases the diversity of the population (see Section 4).

White River Spring Chinook Program

Artificial propagation of White River spring Chinook was initiated in 1999 as a captive-broodstock program. The program is guided by a committee of co-managers and Grant PUD as the funding entity. Implementation of this program has been on a limited basis and no permanent facilities have been developed in the basin.

Eyed-eggs were collected from redds deposited by naturally spawning salmon in the White River beginning in 1999 (Petersen and Dymowska 1999). Because of unsuccessful attempts to propagate this stock, the first yearling smolt release occurred in the spring of 2004. The White River is the only source for eggs used as brood fish.

Genetic analyses of fish sampled from the White River indicate that it is a unique stock relative to other stocks throughout the Columbia River Basin. However, based on the relatively small size of the White River and the short distance to other spawning areas it was not identified as an independent population (ICBTRT 2004b). It is assumed that the eggs collected from naturally deposited redds are genetically similar to eggs remaining in redds. Because strays from the Chiwawa River Program are present on the spawning grounds, this assumption should be verified through genetic sampling. Because this program is new and has not had time to produce adult returns, information regarding life history characteristics, smolt to adult survival, and ability to successfully reproduce in the natural environment is not available.

The White River program is designed to be integrated with the natural population and is intended to increase the number of White River spring Chinook adults on the spawning grounds. After hatching, fish are reared in a hatchery facility until maturity, which can occur at three to six years. These fish are spawned and their progeny are reared to a yearling smolt stage. The smolts are tagged or marked for monitoring purposes and subsequently released into the White River. Gametes collected from naturally produced White River spring Chinook may be used to augment the gametes from the adults reared in captivity.

Program performance results are not available because only one release of juveniles has occurred. Continued operation of this program as either a captive brood program or as a program that rears fish only to the smolt stage before their release is likely because the program is identified as an action for funding under the Biological Opinion for ESA Section 7 Consultation on Interim Operations for the Priest Rapids Hydroelectric Project (NMFS 2004).

Nason Creek River Spring Chinook Program

Artificial propagation of about 250,000 Nason Creek spring Chinook yearling smolts is proposed as mitigation for the Priest Rapids Hydroelectric Project. Implementation of the program is guided by a committee with representatives from co-managers and the funding entity, Grant PUD. A comprehensive supplementation plan and monitoring and evaluation plan consistent with recommendations from the Independent Scientific Advisory Board is being developed. The goal will be similar to that of the Chiwawa program described above. Planning is underway for adult collection and juvenile rearing facilities for this program with input and cooperation from Nason Creek landowners.

As proposed, the program will be an integrated supplementation program using locally derived spring Chinook returning to Nason Creek. Monitoring of this program will include periodic genetic analysis of hatchery and naturally produced fish, various life-history characteristics such as run and spawn timing, adult redd counts and carcass surveys, and juvenile emigrant enumeration to assess productivity of natural spawners.

The program is intended to increase the number of adults on the spawning grounds and subsequently lead to an increase in natural production. As noted above, the Chiwawa program monitoring indicates that the Chiwawa program may have increased the abundance of naturally produced adults. Implementation of this program combined with a reduction in the production level of the Chiwawa program is intended to reduce the risks associated with hatchery programs and allow them to be implemented in a manner more consistent with Hatchery Scientific Review Group (HSRG), Independent Scientific Advisory Board (ISAB), and Independent Scientific Review Panel (ISRP) guidance.

Leavenworth National Fish Hatchery Spring Chinook Program

Leavenworth National Fish Hatchery has released spring Chinook into Icicle Creek since 1940, except for brood years 1967 and 1968. The program is intended to mitigate for the construction of Grand Coulee Dam by providing salmon for harvest, primarily in the Columbia River and in Icicle Creek. Chinook released from the LNFH are not part of the spring Chinook ESU.

Broodstock were originally collected from commingled upriver stocks intercepted at Rock Island Dam (1940-1943) (Cooper et. al 2002). From 1955 through 1964, about 500 spring Chinook were trapped annually at Bonneville Dam, transported to Carson National Fish Hatchery and spawned there. The progeny of those adults continue to be raised and released at Carson National Fish Hatchery and are referred to as “Carson Stock.” Recently collected genetic data indicate that these fish are a mixture of Upper Columbia and Snake River populations that are highly domesticated (Waples et al. 2004; Campton, in press). Before 1985, Carson stock eggs were imported from Carson National Fish Hatchery. Beginning in 1985, broodstock consisted of Leavenworth program adult returns that volunteer into the hatchery on Icicle Creek. Program broodstock are segregated from the natural population in the Wenatchee River basin.

The LNFH spring Chinook program is a segregated program designed to provide salmon for harvest. Recent releases have been entirely marked (adipose fin clipped and coded-wire tagged) before release. This level of marking is needed for hatchery evaluation, potential selective harvest, and to determine straying ratios onto spawning grounds.

This isolated program is funded by the Bureau of Reclamation to provide a treaty and non-treaty spring Chinook harvest. Broodstock are collected as volunteers to the hatchery facility, and little natural production occurs in Icicle Creek. Average returns (6,000+ annually) have been substantial, on average constituting 54% of all spring Chinook passing Rock Island Dam since 1985 (Carrie 2002). Tagging studies indicate that LNFH stray rates are generally low (<1%) (Pastor 2004). However, based on expanded carcass recoveries from spawning ground surveys (2001-2004), LNFH and other out-of-basin strays have comprised from 3-27% of the spawner composition upstream of Tumwater Canyon (WDFW, unpublished data).[95]

Outside of the Wenatchee subbasin, LNFH fish have been recovered at Wells Dam on the Columbia River, at the Methow Hatchery on the Methow River, at the Pelton Dam on the Deschutes River, and in the Umpqua River sport fishery (Cooper et al. 2002). Under current operations, Dam 5 on Icicle Creek (river mile 2.9) is a seasonal barrier. The LNFH, working with local citizens, is in the process of implementing a series of fish passage improvements to pass fish upstream of the facility.

The proportion of LNFH fish on spawning grounds upstream of Tumwater Canyon contributes to a high risk rating for diversity. Increased marking efforts and more intensive spawning surveys in natural production areas should provide more definitive data on straying in the future. The hatchery has relatively little effect on spatial structure because Icicle Creek was classified as a minor spawning area (ICBTRT 2004b).

Entiat Subbasin

Entiat Basin Spring Chinook Program

The Entiat National Fish Hatchery has released spring Chinook into the Entiat River annually since 1975. The program is intended to function as a segregated program to augment harvest. Salmon released from the ENFH are not part of the spring Chinook ESU.

Carson stock provided the egg source for the ENFH. The last import of eggs or fish to the program was in 1994. Returning adults that voluntarily enter the hatchery were the primary broodstock in 1980 and continuously since 1983 (Cooper et al. 2002). Few, if any, naturally produced fish are incorporated into the broodstock.

Hatchery and naturally produced fish were historically thought to remain segregated, because hatchery fish voluntarily return to the ENFH via a fish ladder. However, there is no mechanism to guarantee that they do not migrate upstream and spawn with listed spring Chinook. A review of genetic information conducted in 2001 supported the assumption of segregation (Ford et al. 2001). However, this was not verified on the spawning grounds, as very few carcasses were sampled during the spawning ground surveys in the Entiat River in years prior to 2001. Spawning ground surveys in 2000-2003 have indicated that at least some ENFH fish have commingled on the spawning grounds with the natural population. Similarities between

[95] Low risk spawner composition is less than 2% for out-of-basin fish based on ICBTRT diversity guidelines for achieving a VSP.

hatchery-produced and naturally produced fish in terms of smolt-to-adult survival, age-at-return, and other characteristics are unknown at this time.

Before the 1998 brood, only about 30% of each brood group was adipose fin-clipped and coded-wire tagged. Beginning with the 1999 brood, each release group has been 100% adipose fin-clipped and coded-wire tagged.

The artificial propagation of an out-of-basin stock does not improve any of the VSP criteria. When ENFH fish stray into natural production areas they may adversely affect the genetic diversity of the listed population. Although the numbers of hatchery fish straying into the natural production area is low relative to the total return to the hatchery, it is unacceptably high in relationship to the small natural spawning population. The Entiat spring Chinook population was rated at high risk with respect to out-of-basin spawner composition (Section 2; Appendix B). They also may displace the listed stock occupying the same habitat and that may alter the spatial structure of the listed population. The productivity of the naturally produced population is likely reduced by the hatchery stock commingling on the spawning grounds. This could result in a lower abundance of the population intended to be protected under the ESA.

Methow Subbasin

The Methow spring Chinook population is influenced by several artificial propagation programs that release spring Chinook within the Methow subbasin. WDFW operates the Methow Hatchery as a central facility to carry out release programs of spring Chinook into three tributaries in the subbasin, the Methow, Chewuch, and Twisp Rivers. Additionally, the USFWS operates a separate, but related program that releases spring Chinook into the Methow River.

Methow Composite Stock Spring Chinook Program at the Methow Hatchery

WDFW releases Methow Composite stock into the Methow River from an acclimation pond located at the Methow Hatchery. The Methow River (mainstem) program is one-third of a total annual production level of 550,000 yearling smolts. Hence the annual production goal for the Methow River is about 184,000 smolts. WDFW Hatchery Programs began in 1992 with broodstock collected from adult returns in the Chewuch and Twisp rivers. A transition to rearing the Methow Composite stock, which is a combination of Chewuch River and Methow River stocks, began in 1998. The performance of the program is evaluated through an associated monitoring and evaluation program.

The Methow Hatchery has actively managed broodstock collection and mating to maintain stock structure of separate populations in the Chewuch, Twisp, and Methow Rivers. Initially, broodstock was intended to include only naturally produced fish to develop a fully integrated natural population. The initial maintenance of tributary stocks has been difficult because of low adult returns to the basin and presence of out-of-basin stocks. In 1995, all broodstock were collected at the Methow Hatchery outfall or were transferred from WNFH. In 1996 and 1998, the entire run was collected at Wells Dam because the total run of spring Chinook salmon to the Methow River was very small. In 1997, 1999, and 2000, broodstock were collected at Wells Dam and as voluntary returns to the Methow Hatchery outfall. In the remaining years, broodstock was collected from tributary traps and the Methow Hatchery outfall.

Broodstock collection at locations other than tributary traps was not conducive to preserving genetic diversity. Starting in 1996, scale reading, elemental scale analysis, and reading of coded-wire tags were used to identify salmon from the tributary populations. Specific mating was done each year to preserve the tributary genetic diversity and reduce the incorporation of Carson stock fish into the Methow Hatchery programs. In 1998, broodstock from the Chewuch and Methow rivers was combined to develop the Methow Composite stock. Some Carson stock were included in the Methow Composite stock. Since its inception, the Methow Composite stock has consisted of 88% hatchery fish.

The similarity of hatchery and naturally produced fish has varied among release groups. Several brood groups have been influenced (both intentionally and unintentionally) by out-of-basin spring Chinook released from WNFH. Genetic analysis indicates that some release groups were similar to the Carson stock. Considering the substantial changes in the implementation of the Methow River program, studies to evaluate the genetic characteristics of returning adults is warranted. Age-at-return of hatchery Chinook is younger than naturally produced Chinook. Twenty percent and 70% of hatchery produced fish return as three and four year olds, respectively, compared to naturally produced fish for which return percentages are 9, 37, and 55 for three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, N = 1,892 hatchery produced fish and N = 525 naturally produced fish) (M. Humling, WDFW, personal communication).

The Methow Hatchery was designed to enhance the natural production of spring Chinook in the Chewuch, Methow, and Twisp rivers without changing genetic characteristics (Bartlett and Bugert 1994). The annual production level of the Methow Hatchery as a whole was initially set at 738,000 and subsequently reduced to 550,000 smolts in 1998 because of a change in rearing criteria. The production level of 550,000 smolts is generally intended to be equally divided among the three release ponds. This results in a production level of about 184,000 smolts for release into the Methow River annually. Actual program releases have ranged from about 4,400 smolts in 1994 to about 332,000 smolts in 1997. In the early years of the program all smolts were marked with an adipose fin-clip and coded-wire tag. In more recent years, smolts have not been fin-clipped (to avoid selective fisheries), but they continue to be marked with coded-wire tags for monitoring purposes.

Redd counts and carcasses sampled on the spawning grounds were used to assess returns of hatchery fish and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and WNFH programs) contributed 96% of the natural spawning population in the Methow River during 2001-2003.

The program is intended to foster natural production by annually contributing adults to the spawning population. The collection of nearly 100% of the run in two years (due to extremely low adult returns) and difficulty in collecting naturally produced fish for broodstock has resulted in over 88% average of hatchery fish in the annual broodstocks. Smolt-to-adult return survival was 0.81% for the 1998 brood (the only complete life cycle of the Methow Composite stock) (A. Murdoch , WDFW, personal communication). Before the use of Methow Composite stock, the Methow River stock averaged a release-to-adult survival of 0.29% (A. Murdoch, WDFW, personal communication). The stray rate to other subbasins is currently unknown.

The Methow Composite spring Chinook program at the Methow Hatchery has been successful in returning adult hatchery Chinook to the spawning grounds. The reproductive success of these fish is unknown. The effects on diversity are intended to be managed by incorporating naturally produced Chinook into broodstock annually. However, achieving this objective has been difficult in many years because of low numbers of naturally produced fish returning to the subbasin and tributary traps that are relatively ineffective at capturing adults. The low effectiveness of tributary traps has led to the collection of most broodstock at the Methow Hatchery outfall. It is unlikely that substantial numbers of naturally produced Chinook return to the off-channel hatchery outfall; therefore, few naturally produced fish are collected.

The diversity of the population has likely been decreased by combining Methow River and Chewuch River stocks with Carson stocks. Although Carson stock fish are no longer included in the crossings, their lineage may be present in the broodstock for several generations. Additionally, because of low adult returns in some years, the percentage of hatchery fish on spawning grounds was high. Because the effect on productivity and diversity is unknown at this time, additional monitoring is needed.

Methow Composite Spring Chinook Program at the Winthrop National Fish Hatchery

The use of Carson stock has been phased out and replaced with Methow Composite stock at the WNFH. This facility is just downstream of the Methow Hatchery on the Methow River. The WNFH planted spring Chinook into the Methow River from 1941-1961 and from 1974 to the present.

Historically, broodstock for the WNFH were collected from Chinook that voluntarily entered the hatchery ladder. Beginning in 1998, the Methow Composite stock program was developed, and the management objective of the WNFH was modified to support conservation of the localized stocks. In 2001, access to the ladder was blocked and excess hatchery fish were forced to remain in the Methow River per the 2001 Methow Agreement between the agencies and tribes. The Methow Hatchery and WNFH have increasingly worked together in broodstock collections and spawning activities. WNFH has used few naturally produced fish for broodstock throughout its history (Cooper et al. 2002). In recent years, all of the naturally produced spring Chinook available for hatchery broodstock have been prioritized for the Methow State Fish Hatchery program (B. Cates, USFWS, personal communication).

The similarity of hatchery and naturally produced fish has varied among release groups. The recent use of the Methow Composite stock is intended to increase the similarity of hatchery and naturally produced fish. Considering the substantial program changes, studies to evaluate the genetic profile of the fish are warranted. Age-at-return of hatchery Chinook is younger overall than it is for naturally produced Chinook.

The original intent of the WNFH was to provide spring Chinook for harvest. Since the listing of spring Chinook, the program has changed to propagating Methow Composite stock in order to contribute to the recovery of the Methow population. The annual target production level is 600,000 spring Chinook smolts. Before the 1994 brood, only a portion of the smolts were marked with adipose fin clips and coded-wire tags. Recent releases of Carson stock were 100% adipose fin clipped and coded-wire tagged. Releases of Methow Composite stock have not been fin clipped (to avoid selective fisheries), but they are coded-wire tagged for monitoring purposes.

Redd counts and carcasses sampled on spawning grounds were used to assess hatchery fish returns and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and Winthrop NFH programs) contributed 96% of the fish on the spawning grounds in the Methow River in recent years (Hubble and Theis 2003; Cooper et al. 2002). Smolt-to-adult return rates for Methow Composite stock released from WNFH are not yet available. The effect of hatchery spawners from WNFH on the natural production is unknown. The stray rate to other subbasins is also unknown.

Because of the recent conversion to Methow composite stock, the WNFH should have the same effects on diversity and productivity of naturally produced spring Chinook as the Methow State Fish Hatchery Program.

Chewuch River Spring Chinook Program

A Chewuch River stock was initially maintained at the Methow Hatchery, but a transition to the Methow Composite stock was initiated in 1998. Future releases will be the Methow Composite stock. This program goal is one-third of the Methow Hatchery spring Chinook program.

The first smolt releases were the progeny of naturally produced Chinook collected at Fulton Dam on the Chewuch River and elsewhere within the Chewuch River. The Chewuch River stock was used from 1992 through 1997. Starting in 1998, the program transitioned to the Methow Composite stock (Methow River and Chewuch River stocks). Exclusion of Carson stock for broodstock is achieved by conducting scale analysis and reading coded-wire tags at spawning.

The similarity of hatchery and naturally produced fish has varied among release groups. Considering the substantial changes in the implementation of the Chewuch River program, studies to evaluate the genetic characteristics of the stock are warranted. As in other programs, age-at-return of hatchery fish is younger overall than naturally produced Chinook.

The production goal for the Chewuch program is 183,000 spring Chinook smolts for release into the Chewuch River annually. Actual program releases have averaged 123,970 since the program was started in 1992. The average production achieved is less than the target level because of low run sizes, ineffective traps, and the prioritization of maintaining stock integrity over achieving a target production level. In the early years of the program, all smolts were marked with adipose fin clips and coded-wire tags. In more recent years, smolts have not been fin clipped (to avoid selective fisheries), but they continue to receive coded-wire tags for monitoring purposes.

Redd counts and carcasses sampled on the spawning grounds were used to assess hatchery fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed 64% of the broodstock over the last six years and 81% in the most recent three years. Smolt-to-adult return rates averaged 0.09% (1992-1997) (A. Murdoch, WDFW, personal communication). Smolts released from the Chewuch Pond tend to return to the Chewuch River or stray into the Methow or Twisp Rivers. The stray rate to other subbasins is unknown.

The Chewuch spring Chinook program has been successful in returning adult salmon to the Chewuch River spawning grounds. The reproductive success of these fish is unknown. The effects on diversity are minimized by incorporating naturally produced salmon into the broodstock annually. However, achieving this objective has been difficult in many years for several reasons, including low numbers of naturally produced fish returning to the basin and tributary traps that were ineffective. Maintaining and improving the performance of this program will be an important step in moving the population towards viability, while maintaining sufficient abundance to avoid extinction.

The spatial distribution of spring Chinook in the Chewuch River does not appear to have been affected by the program. Hatchery produced adults returning to the Chewuch River commingle with naturally produced returns. The diversity of the population may have decreased by combining the Chewuch stock with the Methow Composite. Before 1998, the Chewuch stock was maintained as a separate stock that incorporated a substantial number of naturally produced fish into the broodstock annually. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery fish. The effect on productivity and diversity of the natural population is unknown at this time. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

Twisp River Spring Chinook Program

Artificial propagation of the Twisp River stock began in 1992. This program goal is one-third of the WDFW Methow Hatchery spring Chinook program.

The Twisp River spring Chinook program has remained segregated from the other stocks. In 1992-1994 and again in 2001-2003, broodstock were collected using a weir placed in the Twisp River. During the years when spring Chinook broodstock were collected at Wells Dam (1996-1999), Twisp stock were identified using scale analysis and coded-wire tag reading. Additionally, some 1996 brood fish of Twisp stock were retained at the Methow Hatchery as a captive broodstock program, which was incorporated in subsequent broods as the fish matured in captivity. An average of 57% of the broodstock has been hatchery fish from 2001-2003. Occasionally, when no fresh milt was available, preserved milt was used to fertilize eggs.

The production goal of the Twisp program is 183,000 spring Chinook smolts for release into the Twisp River annually. Actual program releases have averaged 66,700 smolts in the past three years. The lower production levels have resulted from low run sizes, ineffective traps, disease management, and maintaining stock integrity. In the early years of the program all smolts were marked with adipose fin-clips and coded-wire tags. In more recent years, smolts have not been fin-clipped (to avoid selective fisheries), but they continue to receive coded-wire tags for monitoring purposes. This supplementation program is designed to enhance natural production annually for an indefinite period.

Redd counts and carcasses sampled on spawning grounds were used to assess hatchery fish returns and spatial distribution. The naturally spawning population consisted of 47% of hatchery fish over the last six years and 33% in the most recent three years (A. Murdoch, WDFW, personal communication). Age-at-return of hatchery produced Chinook is younger overall than naturally produced Chinook. Smolt-to-adult return rates averaged 0.14% (1992-1997) (A. Murdoch, WDW, personal communication). Smolts released from the Twisp Pond tend to return to the Twisp River or stray into the Methow River or Chewuch River at a relatively low rate. The stray rate to other subbasins is unknown.

The Twisp spring Chinook program has been successful in returning adult Chinook to the spawning grounds. The effects on diversity have been minimized by incorporating naturally produced Chinook. The spatial distribution of the naturally produced returns may not be affected by hatchery operations. Additional monitoring is needed to understand the effects of this program. Maintaining and improving the performance of the hatchery program will be an important step in moving the population towards viability.

5.3.2 Limiting Factors and Threats

Historic hatchery practices affected the abundance, productivity, spatial structure, and diversity of populations in the Upper Columbia Basin (see Section 3.5). Beginning with the GCFMP, adults were intercepted at Rock Island Dam and planted in various tributaries in the Upper Columbia Basin. This planting of adults may have reduced genetic diversity and possibly also affected abundance and productivity of native populations of spring Chinook and steelhead.[96] The use of out-of-basin stocks may also have contributed to a reduction of population diversity in areas where they contributed to natural spawning.

Both the Entiat and Leavenworth National Fish Hatcheries are intended to function as "segregated" programs producing spring Chinook that are not part of the ESU. Although recent monitoring indicates straying contributes to "high risk" levels in some years and there is concern that the Entiat stock may have introgressed with, or replaced, the locally derived spring Chinook population (Ford et al. 2004). The Winthrop National Fish Hatchery recently moved to the use of local stock. The extent that out-of-basin stock has introgressed with local stock remains unknown in the Methow subbasin.

Although state-operated programs currently emphasize use of locally derived stocks in the tributaries, they can still pose a risk, depending on the implementation of hatchery practices (such as broodstock management, timing of trapping, adult collection locations, juvenile release locations, straying, etc.). For example, the supplementation program in the Chiwawa Basin may be affecting the age-at-return of spring Chinook. Currently, 56% of the naturally produced fish return at age five, while only 15% of the hatchery produced fish return at age five. The return of younger-aged hatchery produced fish may affect reproductive potential and ultimately productivity of naturally produced fish. There is also concern that the large proportion of Wells Hatchery steelhead spawning naturally in the Methow and Okanogan subbasins may pose risks to the DPS's diversity by decreasing local adaptation (NMFS 2004). The reproductive success of hatchery fish produced in supplementation programs that spawn naturally in the wild remains unknown.

The primary threat associated with some past and present hatchery programs within the Upper Columbia Basin may be the introgression of out-of-basin stock into local populations, especially within the Entiat and Winthrop subbasins. This threat may have reduced the diversity of spring Chinook and steelhead in the Upper Columbia Basin. Additional threats include using out-of-basin stock to expand the spatial distribution of extant populations within subbasins[97] and the blocking of fish passage at adult collection facilities. The effects of hatchery practices in the Upper Columbia Basin on productivity are currently unknown. Research on reproductive success of hatchery-produced fish that spawn in the wild is needed to assess effects on productivity.

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[96] At the time of plantings, Chinook and steelhead populations in the tributaries had been virtually decimated (Fish and Hanavan 1948).

[97] The use of out-of-basin stock to reintroduce a species that is extinct in a subbasin is not considered a threat in this plan, because there is no native stock available if the population is extinct. The reintroduction of an out-of-basin stock of spring Chinook into the Okanogan subbasin is an example.

5.3.3 Hatchery Objectives

The following objectives for hatchery programs apply to both the federal and state-operated facilities in the Upper Columbia Basin. This list is not to be considered all-inclusive. The identified objectives are intended to be consistent with other plans and are intended to reduce the threats associated with hatchery production in the Upper Columbia Basin while meeting other obligations.

Short-Term Objectives

- Continue to use artificial production to maintain critically depressed populations in a manner that is consistent with recovery and avoids extinction.
- Use artificial production to seed unused, accessible habitats.[98]
- Use artificial production to provide for tribal and non-tribal fishery obligations as consistent with recovery criteria.
- Use harvest or other methods to reduce the proportion of hatchery-produced fish in naturally spawning populations (see Section 5.2).
- To the extent possible use local broodstocks in hatchery programs.
- To the extent possible, integrate federal, state, and tribal-operated hatchery programs that use locally derived stocks.[99]
- Reduce the amount of in-basin straying from current hatchery programs.

Long-Term Objectives

- Phase out the use of out-of-basin stock in the federal programs at Leavenworth and Entiat National Fish Hatcheries if continued research indicates that the programs threaten recovery of listed fish and those threats cannot be minimized through operational or other changes.
- Help develop ongoing hatchery programs that are consistent with recovery.
- Provide for tribal and non-tribal fishery obligations.
- Use harvest or other methods to reduce the proportion of hatchery-produced fish in naturally spawning populations (see Section 5.2).
- Manage hatcheries to achieve sufficient natural productivity and diversity to de-list populations and to avert re-listing of populations.

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[98] Hatchery fish should not be introduced into unused habitat unless the habitat is suitable for spawning and rearing of the fish. Therefore, the habitat in degraded streams needs to be restored or improved before hatchery fish are introduced into the stream.
[99] Because state and federal hatchery programs have different objectives and obligations, the programs cannot be fully integrated. However, they can develop common broodstock protocols and production levels that optimize recovery of naturally produced fish.

Research and Monitoring Objectives

- Employ the best available technology to monitor the effects of hatchery releases on natural populations and production (e.g., PUD and Colville Tribes Hatchery Monitoring Programs).
- Develop marking programs to assure that hatchery produced fish are identifiable for harvest management, escapement goals, and reproductive success studies.
- Evaluate existing programs and redesign as necessary so that artificial production does not pose a threat to recovery.
- Integrate and coordinate monitoring activities between federal, state, and tribal programs.
- Examine the reproductive success of naturally produced and hatchery produced spring Chinook and steelhead spawning in the wild.
- Examine steelhead kelt reconditioning and their reproductive success.
- Continue studies to assess the effects of the coho reintroduction program.
- Examine the interactions (competition and predation) between naturally produced and hatchery produced steelhead.
- Continue to examine residualism of hatchery-produced steelhead.
- Examine the feasibility of reintroducing bull trout (including ESA status of introduced stock) into the Chelan and Okanogan subbasins.
- Examine the feasibility (including ESA status of introduced stock) of reintroducing spring Chinook into the Okanogan subbasin.

This plan recognizes the need to balance recovery objectives with legal obligations and mandates under Habitat Conservation Plans (HCPs), the Mitchell Act, federal government and tribal agreements, Hatchery and Genetic Management Plans (HGMPs), ***U.S. v. Oregon***, and relicensing agreements. For example, these recovery objectives are consistent with the Biological Assessment and Management Plan (BAMP) developed by parties negotiating the HCPs for Chelan and Douglas PUDs. BAMP identified the following overriding objectives for hatchery programs associated with the HCPs within the Upper Columbia Basin.

- Contribute to the rebuilding and recovery of naturally spawning populations throughout the Upper Columbia Basin to the point that these populations can be self-sustaining, support harvest, while maintaining genetic and ecologic integrity.
- Compensate the resource for a 7% per hydroproject unavoidable loss as needed to meet the No Net Impact standard of the HCPs.
- Compensate the resource for the original construction impacts of the Upper Columbia River PUD dams in a manner that is consistent with recovery efforts for natural salmonids.

The recovery objectives are also sensitive to the Mitchell Act, which calls for the conservation of the fishery resources of the Columbia River; establishment, operation, and maintenance of one or more stations; and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes. The recovery objectives also consider agreements between tribes and federal agencies, including the coho reintroduction feasibility studies conducted by the Yakama Nation, the Chief Joseph Dam Hatchery Program, and ***U.S. v. Oregon***. One goal of the Chief Joseph Dam Hatchery Program is to reintroduce extirpated spring Chinook into select waters in the Okanogan subbasin. This is an experimental program designed to restore naturally produced spring Chinook and to provide a stable ceremonial and subsistence fishery and recreational fishery in the Okanogan subbasin. Another goal is to restore steelhead in their historical habitats in the Okanogan subbasin and create harvestable surpluses for tribal ceremonial and subsistence fisheries and for recreational harvest.

5.3.4 Recent Hatchery Actions

Changes in hatchery programs have and will continue to reduce risks to naturally produced spring Chinook and steelhead in the Upper Columbia Basin. There are several processes that have changed the way that hatchery programs in the Upper Columbia Basin are implemented. What follows is a brief summary of those processes.

The HGMP process is designed to describe existing artificial production programs, identify necessary or recommended modifications of those programs, and help achieve consistency of those programs with the Endangered Species Act. The HGMP process addresses anadromous salmon and steelhead programs and bull trout.[100]

The Artificial Production Review and Evaluation (APRE) process seeks to document progress toward hatchery reform in the Columbia Basin. The NPCC used consultants and Columbia Basin fishery managers to analyze existing programs and recommend reforms. A draft report has been submitted to the Council and the region. The APRE process includes both anadromous and non-anadromous fish in its analysis.

The Pacific Coastal Salmon Recovery Fund (PCSRF) was established in 2000 to provide grants to the states and tribes to assist state, tribal and local salmon conservation and recovery efforts. The goal of the PCSRF is to make significant contributions to the conservation, restoration, and sustainability of Pacific salmon and their habitat. The PCSRF's enhancement objective is to conduct activities that enhance depressed stocks of naturally produced anadromous salmonids through hatchery supplementation, reduction in fishing effort on depressed naturally produced stocks, or enhancement of Pacific salmon fisheries on healthy stocks in Alaska. This includes supplementation and salmon fishery enhancements.

In 1988, under the authority of ***U.S. v. Oregon***, the states of Washington, Oregon, and Idaho, federal fishery agencies, and the treaty tribes agreed to the Columbia River Fish Management Plan (CRFMP), which was a detailed harvest and fish production process. The CRFMP expired in 1998 and is currently operating under an interim agreement. The fish production section reflects current production levels for harvest management and recovery purposes.

Current ESA Section 10 Permits for listed summer steelhead (Permit #1395); listed spring Chinook (Permit #1196), and non-listed anadromous fish (Permit # 1347) also direct artificial production activities associated with the habitat conservation plans. Douglas PUD, Chelan PUD,

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[100] Bull trout are covered under Section 15 of the HGMPs.

and WDFW are co-permittees; therefore, provisions within the permits and associated Biological Opinions are incorporated into the hatchery programs undertaken in the HCPs.

Under current settlement agreements and stipulations (FERC processes), the three mid-Columbia PUDs pay for implementation of hatchery programs within the Upper Columbia Basin. These programs determine the levels of hatchery production needed to mitigate for the construction and continued operation of the PUD dams. These are conservation programs designed to contribute to the recovery of listed spring Chinook and steelhead.

Habitat Conservation Plans (HCPs) and the Priest Rapids Salmon and Steelhead Settlement Agreement were signed by Douglas and Chelan PUDs (HCPs) and Grant PUD (Settlement Agreement), WDFW, USFWS, NOAA Fisheries, the Yakama Nation, and the Colville Confederated Tribes. The overriding goal of the HCPs and the Settlement Agreement is to achieve no-net impact (NNI)[101] on anadromous salmonids as they pass Wells (Douglas PUD), Rocky Reach, and Rock Island (Chelan PUD), Wanapum, and Priest Rapids (Grant PUD) dams. One of the main objectives of the hatchery component of NNI is to provide species specific hatchery programs that may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest.

The Biological Assessment and Management Plan (BAMP) was developed by parties negotiating the HCPs in the late 1990s. The BAMP was developed to document guidelines and recommendations on methods to determine hatchery production levels and evaluation programs. It is used within the HCP as a guiding document for the hatchery programs.

All of these processes have affected the hatchery programs within the Upper Columbia Basin in one way or another. For example, the Winthop National Fish Hatchery changed their production to be integrated with the listed component, while options for changes in operations at the other two federal facilities are being discussed. NOAA Fisheries has concluded that the locally derived fish produced in hatcheries are essential for recovery of spring Chinook and steelhead DPSs.

Additional changes resulting from various processes includes production of tributary-specific stocks of hatchery steelhead that reduce the potential effects of hatchery fish on naturally produced fish, re-initiation of sport harvest on hatchery steelhead to reduce potential effects of hatchery fish on naturally produced fish, and development of standardized monitoring and evaluation plans for hatchery programs in the Upper Columbia Basin. Although these actions are intended to contribute to recovery of listed species, additional actions are needed to meet recovery objectives.

5.3.5 Hatchery Recovery Actions

Recovery actions listed below for each population are intended to reduce threats associated with hatchery practices in the Upper Columbia Basin. These actions primarily address threats

[101] NNI refers to achieving a virtual 100% survival of anadromous salmonids as they pass the mainstem projects. This is achieved through at least 91% survival of adults and juveniles (or 93% for juveniles) passing the projects, and a maximum 7% compensation through hatchery programs and 2% contribution through a tributary fund, which will fund projects to improve salmonid habitat in the tributaries.

associated with VSP criteria for productivity, diversity, and spatial structure. Actions and mitigation associated with hatcheries throughout the Upper Columbia River Basin should not preclude the recovery of Upper Columbia spring Chinook, steelhead, and bull trout. Additionally, future hatchery facilities will support recovery goals, and minimize and mitigate any impacts (including goals within other Hs). This list should not be considered all inclusive and specific actions will be determined and negotiated by the responsible parties.

Spring Chinook

Wenatchee Population

Within the Wenatchee subbasin, spring and summer Chinook, sockeye, steelhead, and coho salmon are planted for various mitigation programs (**Table 5.3**). The Leavenworth National Fish Hatchery (LNFH) and the Rock Island Fish Hatchery Complex (RIFHC) propagate fish in the Wenatchee subbasin.

Short-term Actions

- LNFH—Continue to release spring Chinook into Icicle Creek to provide treaty and non-treaty harvest opportunities.
- RIFHC—Continue to propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Wenatchee subbasin.
- Reduce the amount of in-basin straying from current hatchery programs.
- Provide fish passage at Dam 5 on Icicle Creek provided that LNFH change to local spring Chinook stock and there is suitable spawning and rearing habitat upstream of the hatchery.
- Reduce or eliminate presence of out-of-basin stock (Carson spring Chinook) on spawning grounds.
- Employ mechanisms to manage hatchery returns on spawning grounds in balance with naturally produced fish, e.g., tribal and sport fisheries, removal at Tumwater Dam and Chiwawa weir, and other methods may be used to remove hatchery fish in excess of management objectives.
- Size hatchery programs appropriately for available habitat given survival trends.

Long-term Actions

- LNFH—Release spring Chinook into Icicle Creek to provide for treaty and non-treaty harvest opportunities.
- RIFHC—Continue to propagate locally derived stock in the Wenatchee subbasin to mitigate for losses at Rock Island Dam and to supplement natural production.
- To the extent possible, integrate federal and state hatchery programs that use locally derived spring Chinook in the Wenatchee subbasin.
- Continue to propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Wenatchee subbasin.

- Modify hatchery programs to minimize adverse impacts of hatchery fish on naturally produced fish while maintaining production levels identified in various agreements.

Research and Monitoring Actions

- Develop an integrated and coordinated monitoring program that uses the best available technology and captures all artificial propagation programs in the subbasin.
- Develop a coordinated marking program so that all hatchery produced spring Chinook in the Wenatchee subbasin are marked to aid harvest management, monitoring, and research.
- Continue to assess the degree that out-of-basin stock from the LNFH spawn with native spring Chinook in the wild.
- Assess the reproductive success of hatchery produced spring Chinook that spawn in the wild.
- Monitor the genetic integrity of naturally produced spring Chinook in the Wenatchee subbasin.
- Determine if supplementation programs in the Wenatchee subbasin affect the VSP parameters of spring Chinook.
- Continue to evaluate the effects of coho reintroduction on recovery of spring Chinook in the Wenatchee subbasin.

Entiat Population

Currently, the spring Chinook program at the Entiat National Fish Hatchery is the only hatchery program within the Entiat subbasin (**Table 5.4**).

Short-term Actions

- Reduce or eliminate presence of out-of-basin stock on spawning grounds.
- Reduce the amount of in-basin straying from current hatchery programs.

Long-term Actions

- Reduce or eliminate presence of out-of-basin stock on spawning grounds.
- If propagation occurs, use locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Entiat subbasin.

Research and Monitoring Actions

- Examine the feasibility and need for the hatchery program to keep the Entiat population from going extinct.
- If a propagation program is necessary, determine the most appropriate “locally derived” stock to use.
- Continue to monitor the genetic integrity of the naturally produced spring Chinook salmon in the subbasin.

- If any spring Chinook hatchery releases continue, assess the reproductive success of ENFH spring Chinook that spawn in the wild.

Methow Population

Artificial production of anadromous fish in the Methow subbasin includes spring Chinook, summer Chinook, steelhead, and coho salmon (**Table 5.5**). The Winthrop National Fish Hatchery (WNFH) and the Methow Fish Hatchery Complex (MFHC) propagate fish in the Methow subbasin.

Short-term Actions

- Increase the use of naturally produced spring Chinook in the hatchery program.
- Incorporate naturally produced fish in broodstock to maintain genetic integration with naturally produced stock
- Employ mechanisms to manage hatchery returns on spawning grounds in balance with naturally produced fish
- Reduce or eliminate presence of out-of-basin stock on spawning grounds.
- To the extent possible, integrate and coordinate federal and state hatchery programs that use locally derived spring Chinook in the Methow subbasin.

Long-term Actions

- WNFH—Continue to propagate locally derived stock in the Methow subbasin to provide for harvest opportunities as natural production increases, incorporate natural spawners into the broodstock.
- MFHC—Continue to propagate locally derived stock in the Methow subbasin to mitigate for losses at Wells Dam and to supplement natural production.
- Propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Methow subbasin.
- Modify hatchery programs to minimize adverse impacts of hatchery fish on naturally produced fish while maintaining production levels identified in various agreements.

Research and Monitoring Actions

- Continue an integrated and coordinated monitoring program that uses the best available technology and captures all artificial propagation programs in the subbasin.
- Continue a coordinated marking program so that all hatchery produced spring Chinook in the Methow subbasin are marked to aid harvest management, monitoring, and research.
- Assess the reproductive success of hatchery-produced spring Chinook that spawn in the wild.
- Monitor the genetic integrity of naturally produced spring Chinook in the Methow subbasin.
- Determine if natural production in the Methow subbasin is increasing from the artificial propagation programs in the subbasin.

- Determine if supplementation programs in the Methow subbasin affect the VSP parameters of spring Chinook.
- Continue to evaluate the effects of coho reintroduction on recovery of spring Chinook in the Methow subbasin.

Okanogan Population

Currently, there are releases of summer Chinook, steelhead, and experimental programs for spring Chinook and sockeye (in Canada) in the Okanogan subbasin (**Table 5.7**). Spring Chinook were extirpated from the Okanogan subbasin before the 1930s. Although there has not been a formal mitigation program for spring Chinook, there is currently an experimental spring Chinook propagation program in the Okanogan subbasin through a cooperative agreement between NOAA Fisheries, USFWS, Colville Tribes, and WDFW. This is an interim segregated program designed to support tribal ceremonial and subsistence fishing and provide information for a proposed, long-term integrated recovery program.

Short-term Actions

- Introduce spring Chinook into the Okanogan subbasin in a manner that does not increase ESA liabilities for landowners.
- Manage the program such that the stock does not stray into other subbasins and do not threaten the diversity of extant populations.

Long-term Actions

- Introduce spring Chinook into the Okanogan subbasin in a manner that does not increase ESA liabilities for landowners.
- If a viable population of spring Chinook can be established in the Okanogan subbasin, use the established local stock in the Okanogan to supplement natural production in the subbasin.
- Continue to release spring Chinook to provide for ceremonial and subsistence fishing and recreational harvest.
- Propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Okanogan subbasin.

Research and Monitoring Actions

- Continue to examine the feasibility of establishing spring Chinook in the Okanogan subbasin.
- Develop a coordinated marking program so that all hatchery-produced spring Chinook are marked to aid harvest management, monitoring, and research.
- Determine if hatchery fish produced in this program stray into other subbasins.
- Assess the reproductive success of hatchery-produced spring Chinook that spawn in the wild.
- Use the best available technology to monitor the effectiveness of the hatchery program.

Steelhead

Wenatchee Population

There are currently no federal programs that propagate steelhead in the Wenatchee subbasin. WDFW, through the RIFHC, release steelhead as compensation for mitigation for both Rock Island and Rocky Reach dams (**Table 5.3**). All steelhead produced in this program are listed under the ESA.

Short-term Actions

- Continue to propagate locally derived steelhead in the Wenatchee subbasin under the state-operated program.
- Continue to employ mechanisms to manage hatchery returns on spawning grounds in balance with naturally produced fish
- Restore steelhead into accessible and suitable habitat if feasible.
- Reduce or eliminate presence of out-of-basin stock on spawning grounds.

Long-term Actions

- Continue to propagate locally derived steelhead in the Wenatchee subbasin to mitigate for losses at Rock Island and Rocky Reach dams and to supplement natural production.
- Propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Wenatchee subbasin.
- Modify hatchery programs to minimize adverse impacts of hatchery fish on naturally produced fish while maintaining production levels identified in various agreements.

Research and Monitoring Actions

- Determine if natural production is increasing as a result of the RIFHC program.
- Conduct research to confirm that hatchery produced fish have no significant effect on the diversity of locally derived populations.
- Use the best available technology to monitor homing, straying, release strategies, and genetic integrity.
- Develop a coordinated marking program so that all hatchery-produced steelhead in the Wenatchee subbasin are marked to aid harvest management, monitoring, and research.
- Assess the reproductive success of hatchery-produced steelhead that spawn naturally in the wild.
- Examine the feasibility and need for steelhead kelt reconditioning in the Wenatchee subbasin.
- Determine if supplementation programs in the Wenatchee subbasin affect VSP parameters of steelhead.

- Examine interactions (competition and predation) between hatchery produced and naturally produced steelhead.
- Continue to assess residualism of hatchery-produced steelhead in the Wenatchee subbasin.
- Continue to evaluate the effects of coho reintroduction on recovery of steelhead in the Wenatchee subbasin.

Entiat Population

No hatchery-produced steelhead are currently released in the Entiat subbasin. Discontinuous stocking of the Entiat and Mad rivers occurred from 1937-1967, with annual stocking of the Entiat River from 1967-1999. The BAMP identified this subbasin as a "reference" stream, which caused the cessation of hatchery steelhead releases in the Entiat Subbasin in 1999; although the HCP Hatchery Committee has not determined at this time if this will occur. Researchers and managers intend to compare productivity between streams that receive hatchery supplementation with streams, such as those in the Entiat, that do not. Recent discussions with local stakeholders, however, have raised questions concerning the use of the Entiat as a reference stream. The designation of a reference stream will not preclude fishing.

Short-term Actions

- Maintain existing practice of not releasing hatchery-produced steelhead into the Entiat subbasin.

Long-term Actions

- If adult steelhead abundance reaches critically low numbers, initiate a hatchery supplementation program to prevent the population from going extinct.

Research and Monitoring Actions

- Determine the feasibility and need of a hatchery program to keep the Entiat steelhead population from going extinct.
- Use the best available technology to monitor the genetic integrity of steelhead in the Entiat subbasin.
- Monitor the presence of steelhead strays (i.e., steelhead produced in other programs) in the Entiat subbasin.
- Determine the efficacy of using the Entiat as a reference stream in the BAMP.

Methow Population

Hatchery produced steelhead have been a dominant part of the spawning population in the Methow subbasin for many years. However, the objectives of the hatchery programs have recently changed from a strictly harvest augmentation role to the added role of recovery. Harvest is still an important objective, but emphasis has shifted in an effort to increase natural spawners.

The WNFH, operated by the USFWS, produces a small number (100,000 fish) of steelhead in the Methow subbasin (**Table 5.5**). This stock is taken from the Wells Fish Hatchery (WFH) and is listed under the ESA.

The Wells Fish Hatchery, operated by WDFW, collects steelhead from the run-at-large at the west ladder trap at Wells Dam. Starting in 2003, naturally produced fish were also collected from the east ladder trap to incorporate a larger number (33%) of naturally produced steelhead into the broodstock. Adults are spawned and reared at the WFH. WDFW annually transports and releases 350,000 steelhead smolts into the Twisp, Chewuch, and Methow rivers (**Table 5.5**).

Short-term Actions

- WFH—Coordinate with HCP Hatchery Committees in developing tributary-specific broodstock collection programs (e.g., in the Twisp, Chewuch, Methow rivers).
- Continue to employ mechanisms to manage hatchery returns on spawning grounds in balance with naturally produced fish.
- To the extent possible, integrate and coordinate federal and state hatchery programs that use locally derived steelhead in the Methow subbasin.
- Reduce or eliminate presence of out-of-basin stock on spawning grounds.

Long-term Actions

- WNFH—Propagate and externally mark locally derived stock in the Methow subbasin to supplement natural production and to provide for harvest opportunities.
- WFH—Propagate locally derived stock in the Methow subbasin to mitigate for losses at Wells Dam, to supplement natural production, and to provide harvest opportunities.
- Propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Methow subbasin.
- Modify hatchery programs to minimize adverse impacts of hatchery fish on naturally produced fish while maintaining production levels identified in various agreements.

Research and Monitoring Actions

- Develop an integrated and coordinated monitoring program that uses the best available technology and captures all artificial propagation programs in the subbasin.
- Determine the feasibility of tributary-specific broodstock collection.
- Continue a coordinated marking program so that all hatchery-produced steelhead in the Methow subbasin are marked to aid harvest management, monitoring, and research.[102]
- Monitor the genetic integrity of naturally produced steelhead in the Methow subbasin.
- Assess the reproductive success of hatchery-produced steelhead that spawn in the wild.

[102] Only hatchery fish that are intended to support a fishery should receive adipose fin clips. Hatchery fish released for conservation or recovery purposes should be marked (e.g., elastomer tag), but not fin clipped. This will reduce the probability that these fish are harvested.

- Determine if natural production in the Methow subbasin is increasing from the artificial propagation programs in the subbasin.
- Determine if supplementation programs in the Methow subbasin affect VSP parameters of steelhead.
- Examine interactions (competition and predation) between hatchery produced and naturally produced steelhead.
- Continue to assess residualism of hatchery-produced steelhead in the Methow subbasin.
- Examine the feasibility and need of steelhead kelt reconditioning in the Methow subbasin.
- Continue to evaluate the effects of coho reintroduction on recovery of steelhead in the Methow subbasin.

Okanogan Population

Steelhead released into the Okanogan subbasin are spawned and reared at the WFH, operated by WDFW. Juvenile hatchery produced steelhead are transported to the Okanogan subbasin and scatter planted in the Similkameen River (50,000), Omak Creek, Salmon Creek, and the Okanogan River (50,000) during spring (**Table 5.7**).

In 2003, the Colville Tribes initiated a local broodstock program, collecting steelhead returning to Omak Creek. Eggs are incubated and juvenile steelhead are reared at the Colville Trout Hatchery (CTH). This is a recovery program with the goal of releasing 20,000 smolts in the Okanogan subbasin.

Short-term Actions

- To the extent possible, use locally derived steelhead in the CTH program.
- Continue to employ mechanisms to manage hatchery returns on spawning grounds in balance with naturally produced fish.
- Finish a comprehensive steelhead HGMP for the Okanogan subbasin that promotes recovery and provides harvest opportunities.

Long-term Actions

- Propagate locally derived steelhead into the Okanogan subbasin to supplement natural production and to provide harvest opportunities.
- Propagate locally derived stock consistent with low to moderate risk VSP criteria for major spawning areas in the Okanogan subbasin.
- Modify hatchery programs to minimize adverse impacts of hatchery fish on naturally produced fish while maintaining production levels identified in various agreements.

Research and Monitoring Actions

- Determine the feasibility and need of tributary-specific broodstock collection (in addition to the Omak collection facility).

- Develop a coordinated marking program so that all hatchery produced steelhead in the Okanogan subbasin are marked to aid harvest management, monitoring, and research.
- Monitor the genetic integrity of naturally produced steelhead in the Okanogan subbasin.
- Assess the reproductive success of hatchery-produced steelhead that spawn in the wild.
- Determine if natural production in the Okanogan subbasin is increasing from the artificial propagation programs in the subbasin.
- Determine if supplementation programs in the Okanogan subbasin affect VSP parameters of steelhead.
- Examine interactions (competition and predation) between hatchery produced and naturally produced steelhead.
- Assess residualism of hatchery-produced steelhead in the Okanogan subbasin.
- Examine steelhead kelt reconditioning in the Okanogan subbasin.
- Assess the potential for reintroduction of steelhead into Canadian waters.

Bull Trout

There are currently no hatchery programs for bull trout in the Upper Columbia Basin. However, there is a possibility that hatchery programs for other species may have affected the abundance, productivity, spatial structure, and diversity of bull trout in the Upper Columbia Basin.

Wenatchee Core Area

There is no bull trout hatchery program in the Wenatchee Core Area. However, the stocking of brook trout negatively affects the abundance, productivity, spatial structure, and diversity of bull trout in the core area (USFWS 2002).

Short-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.
- Develop a multi-agency approved process for a brook trout removal program in bull trout core areas.

Long-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.

Research and Monitoring Actions

- Examine the extent that brook trout have hybridized with bull trout in the Wenatchee Core Area.
- Continue collection of trend and redd count data.

Entiat Core Area

There is no bull trout hatchery program in the Entiat Core Area. However, the stocking of brook trout negatively affects the abundance, productivity, spatial structure, and diversity of bull trout in the core area (USFWS 2002).

Short-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.
- Develop a multi-agency approved process for a brook trout removal program in bull trout core areas.

Long-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.

Research and Monitoring Actions

- Examine the extent that brook trout have hybridized with bull trout in the Entiat Core Area.
- Continue collection of trend and redd count data.

Lake Chelan Core Area

There is no bull trout hatchery program in the Lake Chelan Core Area and the presence of bull trout in the core area remains unknown. Bull trout have not been observed in the core area for decades.

Short-term Actions

- None

Long-term Actions

- None

Research and Monitoring Actions

- Examine the effectiveness and feasibility of using fish transfers and hatcheries to assist in possible reintroduction of bull trout into the Lake Chelan Core Area

Methow Core Area

There is no bull trout hatchery program in the Methow Core Area. However, the stocking of brook trout negatively affects the abundance, productivity, spatial structure, and diversity of bull trout in the core area (USFWS 2002).

Short-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.

- Develop a multi-agency approved process for a brook trout removal program in bull trout core areas.

Long-term Actions

- Eliminate stocking brook trout within waterways associated with or connected to bull trout habitat.

Research and Monitoring Actions

- Assess the feasibility of using Patterson Lake bull trout to reestablish local populations of bull trout in the Methow Core Area.

- Examine the extent that brook trout have hybridized with bull trout in the Methow Core Area.

- Continue collection of trend and redd count data.

Okanogan Core Area

There is no bull trout hatchery program in the Okanogan Core Area and the presence of bull trout in the core area is unknown. Bull trout have not been observed in tributaries in the core area for decades. However, bull trout have been occasionally observed in the mainstem Okanogan River (BioAnalysts 2003).

Short-term Actions

- None

Long-term Actions

- None

Research and Monitoring Actions

- Examine the effectiveness and feasibility of using fish transfers and hatcheries to assist in possible reintroduction of bull trout into the Okanogan subbasin.

5.3.6 Responsible Parties

WDFW, USFWS, NOAA Fisheries, the Yakama Nation, and the Colville Tribes are primarily responsible for regulating hatchery activities in the Upper Columbia Basin.

5.3.7 Coordination and Commitments

This plan assumes that an Implementation Team, made up of representatives from various federal and state agencies, tribes, counties, and stakeholders will engage in discussions associated with hatchery actions. This Team will be involved in all issues related to hatchery policies and recovery actions, and will work within the framework of the HCPs for Chelan and Douglas PUDs, Section 7 consultations, the Mitchell Act, HGMPs, ***U.S. v. Oregon***, and federal trust responsibilities to the tribes. If necessary, the Implementation Team may establish a technical committee made up of hatchery managers and scientists to provide technical advice to the Team, review monitoring and research actions associated with hatchery practices, and identify gaps and additional research needs.

The PUDs (state facilities) and federal government (federal facilities) are the primary entities responsible for funding the hatchery programs in the Upper Columbia Basin. Habitat conservation plans and binding mitigation agreements increase the likelihood that these programs have secure funding and will continue operating into the future.

5.3.8 Compliance

Hatchery activities are currently monitored through processes like the HCPs, HGMPs, and Section 7 and 10 consultations. WDFW, USFWS, and tribes are primarily responsible for monitoring the progress and success of hatchery programs in the Upper Columbia Basin. These programs also have evaluation goals and check-ins that provide production targets for the various programs. This recovery plan encourages greater coordination among federal, state, and tribal programs and integration of monitoring programs.

5.4 Hydro Project Actions

5.4.1 Background

Construction of mainstem dams downstream from the Grand Coulee project began with Rock Island in 1933 and culminated with the completion of John Day Dam in 1968. Currently, seven mainstem dams lie between the Wenatchee River and the ocean, eight downstream from the Entiat River, and nine between the Methow/Okanogan systems and the ocean. Dam-related losses can be substantial. Some of the losses result from the physical effects of dams on juvenile/smolt and adult passage; others derive from altered limnological conditions that increase predation by fish and birds.

This recovery plan identifies actions specific to the five hydroelectric projects in the Upper Columbia Basin (Wells Dam, Rocky Reach Dam, Rock Island Dam, Wanapum Dam, and Priest Rapids Dam) and to existing hydroelectric projects in tributaries. No specific recovery actions are identified for federal hydroelectric projects upstream from Wells Dam or downstream from Priest Rapids Dam. However, this plan does recognize that recovery of Upper Columbia stocks may depend upon changes in the operations of federal hydroelectric projects. Hydroelectric projects within tributaries of the Upper Columbia Basin include Trinity, Tumwater, Dryden, Lake Chelan, and Enloe dams. Only the Lake Chelan Hydroelectric Project and Trinity (a small project on Phelps Creek) are currently generating electricity. The other projects have been decommissioned. There are several dams within the Wenatchee, Methow, and Okanogan subbasins that function as irrigation diversions. Actions associated with these projects are addressed in Section 5.5 (Habitat Actions).

5.4.2 Limiting Factors and Threats

The development of hydroelectric projects on the Columbia River has significantly reduced the abundance and spatial structure of spring Chinook, steelhead, and bull trout in the Upper Columbia River Basin (see Section 3.6). In general, hydroelectric projects have affected four major habitat factors: upstream and downstream fish passage, ecosystem structure and function, flows, and water quality. Grand Coulee and Chief Joseph dams have no facilities for upstream passage and thus have had a large effect on the abundance and spatial structure of fish in the Upper Columbia Basin. The five non-federal hydroelectric projects downstream of Chief Joseph Dam on the Columbia River (Wells Dam, Rocky Reach Dam, Rock Island Dam, Wanapum

Dam, and Priest Rapids Dam) have affected the four major factors to a lesser degree, because of modified operations and the presence of fish passage facilities.

The five hydroelectric projects on the mainstem in the Upper Columbia Basin have affected volumes and hourly flow fluctuations in the Columbia River, but to a much lesser degree than Grand Coulee Dam, which primarily controls seasonal, weekly, and daily flows in the Upper Columbia River. Water quality is also affected by dams and their operations. Because the five non-federal hydroelectric projects are "run-of-the-river" dams, they have little effect on water temperatures, compared to Grand Coulee Dam. However, these projects have created localized pockets of high water temperatures along the reservoir shorelines. During spill, these projects can cause gas supersaturation, which may lead to gas bubble trauma in fish. The hydroelectric projects have also replaced riverine habitat by creating impoundments. These modifications have resulted in changes in the habitat and resident fish populations, which affect food web patterns, competition, and predation pressures.

Hydroelectric projects create obstacles that migrating fish must pass. As a result, the more obvious potential effects of hydroelectric projects are observed on juvenile/smolt and adult fish passage, which may affect fish survival and migration timing. There is little evidence that the projects have significantly increased mortality of adult salmon and steelhead migrating upstream through the hydrosystem on the mainstem Columbia River (Toole et al. 2004). There is speculation, however, that adults migrating upstream through the hydroelectric projects may have a lower fitness because of reduced energy reserves (depleted during migration through projects) or increased susceptibility to disease. Currently, research has not demonstrated these effects on fitness. Steelhead kelts and adult bull trout suffer an undetermined loss during downstream migration through the dams. Juveniles and smolts, on the other hand, suffer mortality at each project. Losses may occur because of direct effects of dam passage, delayed mortality, increased predation (both birds and fish), or altered limnological conditions.

The primary threat associated with the operations of the five hydroelectric projects on the Upper Columbia River is a reduction in survival (and thus abundance) of spring Chinook salmon, steelhead, and bull trout. This threat is most apparent in juvenile and smolt life stages and is a result of direct morality at dams and predation by fish and birds. Loss of fish due to gas bubble trauma in the Upper Columbia appears to be low (S. Hays, CPUD, personal communication). The effect of dam operations on rates of adult migration (i.e., delays) and thus on population productivity is poorly understood. Research is needed to assess the threat of hydroelectric projects on fish productivity.

5.4.3 Hydro Project Objectives

The following objectives for hydroelectric projects apply primarily to the projects owned by the PUDs. These objectives are consistent with the Anadromous Fish Agreement and HCPs, relicensing agreements, and Section 7 Consultations. These objectives are intended to reduce the threats associated with hydroelectric development in the Upper Columbia Basin.

Short-Term Objectives

- Continue the actions identified in the Anadromous Fish Agreement and HCPs that will achieve no net impact (NNI) for Upper Columbia steelhead and spring Chinook.

- Implement the actions identified in the Settlement Agreement (2005) and Section 7 Consultation with Grant PUD that will improve spring Chinook and steelhead survival.
- Implement the actions identified in the USFWS biological/conferencing opinion with Douglas and Chelan PUDs that will improve conditions for Upper Columbia bull trout.
- Implement the actions identified in the Lake Chelan Hydroelectric Project relicensing agreement that will provide suitable spawning habitat for steelhead in the tailrace and lower Chelan River (downstream from the natural fish barriers).
- Build hydroelectric dams proposed for construction in the future in the Upper Columbia Basin that have no negative effects on spring Chinook, steelhead, and bull trout VSP parameters.
- Encourage the implementation of actions for federal hydroelectric projects identified in the remanded Federal Columbia River Power System biological opinion.

Long-Term Objectives

- Provide upstream and downstream passage for juvenile/smolt and adult life stages.
- Implement the actions identified in the Lake Chelan Comprehensive Fishery Management Plan to determine the feasibility and possible reintroduction of bull trout into the basin.
- Achieve NNI on species covered under the Anadromous Fish Agreement, HCPs, Settlement Agreements, and Section 7 Consultations.
- Maintain suitable subadult and adult bull trout rearing and passage conditions in the mainstem Upper Columbia River.
- Maintain suitable spawning habitat for steelhead in the lower Chelan River and tailrace.

Research and Monitoring Objectives

- Determine baseline survival estimates for juvenile spring Chinook and steelhead as they pass hydroelectric projects on the Upper Columbia River.
- Evaluate effects of hydroelectric projects on adult passage of spring Chinook, steelhead, and bull trout.
- Evaluate if passage through hydroelectric projects affect spawning success or fitness of spring Chinook, steelhead, and bull trout.
- Evaluate effectiveness of predator control programs.

Most of these objectives are consistent with the legal mandates of the HCPs, Section 7 Consultations, and relicensing agreements. The primary objective of the HCPs is to achieve NNI. If met, this objective would equate to a net productivity equivalent to the productivity that could be attained if these projects did not exist. The HCPs intend to meet NNI primarily through mainstem survival objectives for juvenile and adult salmonids, and through off-site mitigation with hatchery and tributary habitat improvements. The goal is to achieve combined adult and juvenile survival of 91% per project. The remaining 9% will be compensated through hatchery (7%) and tributary (2%) activities.

5.4.4 Recent Hydro Project Actions

Several actions have already been implemented to reduce threats associated with the operation of hydroelectric projects in the Upper Columbia River Basin. Importantly, the HCPs have been incorporated into Chelan and Douglas PUD Federal Energy Regulatory Commission (FERC) licenses. In addition, NOAA Fisheries issued its biological opinion on interim operations of Priest Rapids Hydroelectric Project. These agreements set the stage for implementing hydroelectric actions that are designed to result in NNI to spring Chinook and steelhead, and should improve passage conditions for bull trout.

The PUDs have also implemented downstream passage programs to enhance juvenile/smolt migration and survival. A juvenile bypass system was developed and installed at Wells Dam and recently at Rocky Reach Dam. Grant PUD is currently installing a new turbine and developing an improved fish bypass system at Wanapum Dam. They also plan on completing a new split-pier bypass at Priest Rapids Dam. These systems should increase the survival of juveniles/smolts migrating downstream through the projects. Spill is used at Rock Island, Wanapum, and Priest Rapids dams to increase juvenile/smolt survival at these projects. In addition, the PUDs have implemented measures to decrease the incidence of bird and fish predation on juvenile/smolt migrants. For example, they have bird harassment measures that reduce bird predation on juveniles and have implemented a northern pikeminnow reduction program in the project areas.

Within the Wenatchee subbasin, Chelan PUD has implemented actions that improve fish passage at both Tumwater and Dryden dams. They have also improved fish trapping at Dryden and Tumwater dams to reduce stress on fish returned to the river during broodstock trapping. These activities should reduce the threat that these projects negatively affect the spatial structure and diversity of spring Chinook, steelhead, and bull trout in the Wenatchee subbasin.

5.4.5 Hydro Project Recovery Actions

This plan strengthens the likelihood that all actions and mitigation associated with hydro projects throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Mainstem Columbia River

There are five hydroelectric projects on the Upper Columbia River that are addressed in this plan (Wells Dam, Rocky Reach Dam, Rock Island Dam, Wanapum Dam, and Priest Rapids Dam). Actions associated with each of these projects are identified and orchestrated through the Anadromous Fish Agreement, HCPs, and Section 7 processes. The actions identified in the agreements, HCPs, and in the Biological Opinions are adopted by reference into this plan.

Short-term Actions

- Implement or maintain actions associated with spill and fish-bypass systems identified in the Agreements, HCPs, and Section 7 Consultation to achieve a NNI on spring Chinook and steelhead.

- Implement actions identified in the USFWS Biological/Conference Opinion that address effects of Wells, Rocky Reach, and Rock Island Dam on Upper Columbia bull trout.
- Continue with bird harassment measures and northern pikeminnow reduction actions at mainstem hydroelectric projects.
- Encourage the implementation of actions for federal hydroelectric projects that will increase the survival of Upper Columbia spring Chinook and steelhead.

Long-term Actions

- Achieve and/or maintain a combined juvenile/smolt and adult survival rate of 91% per HCP project (Wells, Rocky Reach, and Rock Island dams).
- If necessary, modify operations to achieve the 91% combined juvenile/smolt and adult survival rate for the three HCP projects.
- Maintain conditions that do not adversely modify or destroy conditions for bull trout.

Research and Monitoring Actions

- Assess survival rates for juvenile/smolt spring Chinook and steelhead.
- Evaluate the efficiency and operation of bypass systems or passage facilities and spill on migrating spring Chinook, steelhead, and bull trout.
- Evaluate the effects of hydroelectric operations on sub-adult bull trout.
- Evaluate the effectiveness of bird control (lethal and non-lethal) and predatory fish control measures.
- Evaluate the effects of hydroelectric passage on reproductive success of spring Chinook, steelhead, and bull trout.

Wenatchee Subbasin

There are two decommissioned hydroelectric projects on the Wenatchee River (Dryden and Tumwater dams) and one small hydro project on Phelps Creek in the Chiwawa Basin. Both Dryden and Tumwater dams have adult fish ladders that were modified to improve adult passage in the late 1980s.

Tumwater Dam was originally used to create electricity for train passage through a tunnel near Stevens Pass. Currently, the dam is used by fishery resource agencies to count fish, capture broodstock for hatchery programs, and for other research. Various modifications have been made to the dam in the last few years to avoid fish passage delays. Resource agencies worked closely with Chelan PUD (the owner) to revise and modify tailrace conditions to quickly attract fish to the ladder at all water flows.

Dryden Dam is currently used to divert irrigation water for the Wenatchee Reclamation District. Broodstock is collected at both the right and left ladders for various hatchery programs.

The owner of the small hydroelectric project on Phelps Creek has applied for a license to generate electricity to be used for residential purposes at Trinity. The agencies are currently negotiating with the owner and are identifying operational goals that will protect spawning and rearing habitat for spring Chinook, steelhead, and bull trout in the upper Chiwawa Basin.

Short-term Actions

- Protect existing spring Chinook, steelhead, and bull trout spawning and rearing habitat in the upper Chiwawa River and Phelps Creek near the Trinity hydroelectric project.
- Maintain effective fish passage at Tumwater and Dryden dams.

Long-term Actions

- Maintain effective fish passage at Tumwater and Dryden dams.
- Maintain hatchery and tributary actions as identified in the HCPs.

Research and Monitoring Actions

- Monitor fish passage at Tumwater Dam.

Entiat Subbasin

There are currently no hydroelectric projects in the Entiat subbasin.

Short-term Actions

- None.

Long-term Actions

- Maintain hatchery and tributary actions as identified in the HCPs.

Research and Monitoring Actions

- None

Lake Chelan Subbasin

There is one hydroelectric project located on the Chelan River. The dam is located just downstream from the mouth of the lake and the powerhouse is located near the community of Chelan Falls. Chelan PUD and the resource agencies signed a settlement agreement for the relicensing of the project that identified several actions intended to improve aquatic conditions for salmon and trout in the lower Chelan River channel (downstream from the natural fish barriers) and in the tailrace. These actions should benefit the abundance and productivity of steelhead in the Upper Columbia DPS. Chelan PUD will implement these actions once NOAA Fisheries issues its biological opinion for the continued operation of the project.

Short-term Actions

- Implement the actions identified in the Lake Chelan Hydroelectric Project relicensing agreement that provide suitable spawning habitat (gravels, cover, and flows) for steelhead in the tailrace and lower Chelan River channel.

Long-term Actions

- Maintain suitable spawning habitat for steelhead in the tailrace and lower Chelan River channel.

Research and Monitoring Actions

- Monitor the use of spawning habitat by steelhead in the tailrace and lower Chelan River channel.
- Assess the effects of powerhouse shutdowns on the incubation success of steelhead in spawning gravels in the tailrace.

Methow Subbasin

There are currently no hydroelectric projects in the Methow subbasin.

Short-term Actions

- None.

Long-term Actions

- Maintain hatchery and tributary actions as identified in the HCPs.

Research and Monitoring Actions

- None

Okanogan Subbasin

There is only one hydroelectric project in the Okanogan subbasin, Enloe Dam on the Similkameen River, and it is currently decommissioned. This dam is located on or near Coyote Falls, which was an upstream fish passage barrier (Copp 1998; Vedan 2002). There is no fish passage at Enloe Dam.

Short-term Actions

- None.

Long-term Actions

- Maintain hatchery and tributary actions as identified in the HCPs.

Research and Monitoring Actions

- None

5.4.6 Responsible Parties

WDFW, WDOE, USFWS, NOAA Fisheries, Colville Tribes, Yakama Nation, Umatilla Tribe, and the PUDs are primarily responsible for overseeing and implementing hydro project activities. The PUDs are primarily responsible for funding hydro project actions.

5.4.7 Coordination and Commitments

This plan assumes that an Implementation Team, made up of representatives from various federal and state agencies, tribes, counties, and stakeholders will engage in discussions associated with hydropower actions. This Team will work with the appropriate technical committees, including the HCPs and Priest Rapids Coordinating Committees and technical committees established under the HCPs. The Implementation Team will also work closely with technical committees established under various relicensing agreements and Section 7 Consultations (e.g., Lake Chelan Hydroelectric Project, Priest Rapids Hydroelectric Project, and the Federal Columbia River Power System).

Habitat conservation plans and relicensing agreements strengthen the likelihood that these programs have secure funding and will continue operating into the future.

5.4.8 Compliance

HCPs, relicensing agreements, and Section 7 Consultations outline operating conditions, goals, and objectives that are incorporated into operating licenses. Hydro project activities are currently monitored through these agreements. The PUDs are primarily responsible to fund implementation and monitoring associated with mitigation requirements and to track progress of hydro actions in the Upper Columbia Basin. Committees established through the FERC processes will be primarily responsible for developing and coordinating the implementation of plans developed in these processes and evaluating monitoring activities.

5.5 Habitat Actions

5.5.1 Background

This plan is based on the well-established fact that spring Chinook, steelhead, and bull trout, like other salmonids, have specific habitat requirements that vary across life stages. This fact is consistent with ecological theory and is supported by numerous independent studies (e.g., see reviews in Bjornn and Reiser 1991; Rieman and McIntyre 1993; Spence et al. 1996; 62 FR 43937; 64 FR 14308; 63 FR 31647). Any land or water management action or natural event that changes habitat conditions beyond the tolerance[103] of the species results in lower life-stage survival and abundance of the species. In some cases, the range of tolerance for some species is quite narrow and relatively small changes in the habitat can have large effects on species survival. For example, bull trout spawning and juvenile rearing occurs within a narrow range of water temperatures (Goetz 1989; Rieman and McIntyre 1993; 40 FR 41162). Activities or natural events that increase water temperatures (>15°C) reduce the distribution and abundance of juvenile bull trout.

In general, spring Chinook, steelhead, and bull trout require cold, clean, connected, and complex habitat (Bjornn and Reiser 1991; Spence et al. 1996). These fish typically grow and survive best in streams with summer temperatures less than 15°C and winter temperatures greater than

[103] Tolerance represents the range of an environmental factor (e.g., temperature, fine sediment, water velocity, etc.) within which an organism or population can survive.

0°C.[104] They prefer streams that are free of toxic pollutants (e.g., heavy metals, urban runoff, and other point- and nonpoint-source pollutants) and lack high levels of fine sediments and high turbidity. These fish are most often found in complex and diverse habitats. For example, juvenile Chinook are most often associated with streams that contain large woody debris (LWD) and pools in low-gradient alluvial valleys.[105] In higher-gradient fluvial canyons, large boulders provide habitat complexity. Juvenile steelhead often rear in these higher-gradient reaches.[106] Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover and areas with cold hyporheic zones or groundwater upwellings. All three species require suitable stream flows for rearing, spawning, and migration. They also require a network of connected spawning and rearing habitats. Areas of suitable spawning and rearing habitats can become fragmented or disconnected by physical barriers (e.g., dams, diversions, dewatering, naturally occurring log jams), chemical barriers (e.g., pollutants), and by unnaturally warm temperatures. If any of these habitat elements are missing or compromised, then abundance, productivity, spatial structure, and diversity of the species is reduced.

Over the decade many books on salmon conservation have emerged (e.g., NRC 1996; Stouder et al. 1997; Lichatowich 1999; Knudsen et al. 2000; Lynch et al. 2002; Montgomery et al. 2003; Wissmar and Bisson 2003), and all agree that habitat restoration should be a cornerstone of any recovery program.[107] As such, this plan aims to address habitat threats by protecting and restoring ecosystem functions or processes whenever and wherever feasible and practical. This approach is science based (but considers socio-economic issues; see Sections 6 and 8) and provides a means for required habitat to be maintained long-term in a dynamic way by natural processes. The implementation of this plan will be sensitive to and consistent with local planning processes, Section 7 and 10 consultations with federal services, local landowner and tribal interests, and reserved and adjudicated rights.

This plan recognizes that at some point the implementation of habitat actions will have diminishing returns (i.e., benefits per cost analysis). In other words, at some point in the future, all improvements, through protection and restoration, will have a very limited affect on fish habitat. This plan promotes an end point of habitat improvements, that when met, will conclude the responsibility of landowner action to improve or preserve habitat.

5.5.2 Limiting Factors and Threats

Past land and water management activities within the Upper Columbia Basin have degraded habitat conditions and compromised ecological processes in some locations (for a more detailed

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[104] It is important to note that local adaptation affects general temperature ranges and literature values are intended to be used as guidelines only.

[105] During a 12-year study in the Chiwawa basin, Hillman and Miller (2004) found that sites with LWD made up on average only 19% (range, 10-29%) of the total stream surface area in the basin, but supported on average 61% (range, 25-77%) of all juvenile Chinook in the basin.

[106] Habitat selected by fish is directly related to their morphology (shape). For example, Bisson et al. (1988) found that the shape of juvenile steelhead is adapted to life in fast water, whereas the shape of juvenile Chinook is adapted for slower-water. Thus, these species will have slightly different habitat requirements.

[107] This does not mean that recovery can be achieved with habitat actions only. Implementation of actions within the other Hs (Harvest, Hatcheries, and Hydropower) is also needed to achieve recovery.

discussion see Section 3.7). Habitat within many of the upper reaches of most subbasins is in relatively pristine condition (e.g., upper reaches of the Wenatchee, Entiat, and Methow subbasins). Human activities have reduced habitat complexity, connectivity, water quantity and quality, and riparian function in many stream reaches in the Upper Columbia Basin. Loss of LWD and floodplain connectivity have reduced rearing habitat for Chinook, steelhead, and bull trout in larger rivers (e.g., Wenatchee, Entiat, Methow, and Okanogan rivers). Fish management, including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species.

This plan relied on several tools to identify and assess habitat conditions, limiting factors, and threats within the Upper Columbia Basin. This included information derived from watershed plans, subbasin plans, limiting factors analysis, the Biological Strategy (UCRTT 2003), EDT, empirical and derived data, and local knowledge and professional judgment. EDT[108] was used to identify the potential for increasing the viability of spring Chinook, steelhead, and bull trout by restoring[109] and protecting habitat in the Upper Columbia Basin. This tool, in combination with limiting factors analysis, watershed plans, subbasin plans, and the Biological Strategy also identified locations within each subbasin that would most benefit from habitat restoration and protection. The lack of data in some subbasins (e.g., Okanogan subbasin) emphasizes the importance of monitoring and adaptive management.

5.5.3 Habitat Objectives

The following objectives for habitat restoration apply to all streams that currently support or may support (in a restored condition) spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. These objectives are consistent with subbasin plans, watershed plans, the Biological Strategy, HCPs, and relicensing agreements and are intended to reduce threats to the habitat needs of the listed species. These objectives may be modified in response to monitoring, research, and adaptive management. These objectives will be implemented within natural, social, and economic constraints.

Short-Term Objectives

- Protect[110] existing areas where high ecological integrity and natural ecosystem processes persist.
- Restore connectivity (access) throughout the historic range where feasible and practical for each listed species.[111]

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[108] See watershed plans, subbasin plans, and Appendix F for a detailed description of the use of EDT.
[109] This plan defines "habitat restoration" as a process that involves management decisions and actions to improve habitat conditions (after Davis et al. 1984). The goal of habitat restoration is to reestablish the ability of an ecosystem to maintain its function and organization without continued human intervention. It does not mandate or even suggest returning to the historic condition (often identified as some arbitrary prior state). Restoration to a previous condition often is impossible.
[110] Protect or protection in this plan refers to ***all*** actions that safeguard required habitat features of listed species. This plan does not recommend land acquisition, unless "no net loss" of the tax base to the county in which the land is being sold is accomplished.

- Where appropriate, establish, restore, and protect stream flows (within the natural hydrologic regime and existing water rights) suitable for spawning, rearing, and migration (based on current research and modeling).
- Protect and restore water quality where feasible and practical within natural constraints.
- Increase habitat diversity in the short term by adding instream structures (e.g., LWD, rocks, etc.) where appropriate.[112]
- Protect and restore riparian habitat along spawning and rearing streams and identify long-term opportunities for riparian habitat enhancement.
- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes where appropriate and identify long-term opportunities for enhancing these conditions.
- Restore natural sediment delivery processes by improving road network, restoring natural floodplain connectivity, riparian health, natural bank erosion, and wood recruitment.
- Replace nutrients in tributaries that formerly were provided by salmon returning from the sea.
- Reduce the abundance and distribution of exotic species that compete and interbreed with or prey on listed species in spawning, rearing, and migration areas.[113]

Long-Term Objectives

- Protect areas with high ecological integrity and natural ecosystem processes.
- Maintain connectivity through the range of the listed species where feasible and practical.
- Maintain suitable stream flows (within natural hydrologic regimes and existing water rights) for spawning, rearing, and migration.

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[111] The distribution of steelhead throughout the Okanogan subbasin (U.S. and Canada) has been severely reduced. Although this plan has no authority to dictate recovery actions in Canada, this plan encourages U.S. managers and scientists to continue to work cooperatively with Canadian managers and scientists in identifying and implementing habitat actions that would benefit Okanogan steelhead. The process for this collaboration currently exists and has been used in subbasin planning.

[112] This plan recommends the use of instream structures (such as boulders and LWD) as an immediate, short-term action to increase habitat diversity. These structures can be used while other actions are implemented to restore proper channel and riparian function (i.e., natural watershed processes). The manual addition of instream structures is usually not a long-term recovery action and should not be used in place of riparian or other restoration activities that promote reestablishment of natural watershed processes. However, if recovery of natural watershed processes cannot be achieved, the use of instream structures is a reasonable option.

[113] This objective is identified as a critical uncertainty in this plan. Depending on the results of research, actions may be identified that directly reduce abundance and distribution of predators and competitors and/or indirectly affect their abundance and distribution by increasing habitat conditions that are favorable to listed species but unfavorable to exotic fish species.

- Protect and restore water quality where feasible and practical within natural constraints.
- Protect and restore off-channel and riparian habitat.
- Increase habitat diversity by rebuilding, maintaining, and adding instream structures (e.g., LWD, rocks, etc.) where long-term channel form and function efforts are not feasible.
- Reduce sediment recruitment where feasible and practical within natural constraints.
- Reduce the abundance and distribution of exotic species that compete and interbreed with or prey on listed species in spawning, rearing, and migration areas.

Administrative/Institutional Objectives

- Maximize restoration efficiency by concentrating habitat actions in currently productive areas with significant scope for improvement and areas where listed species will benefit (Category 1 and 2 areas described in Section 5.5.5).
- Develop incentive and collaborative programs with local stakeholders and land owners to enhance and restore habitat within productive areas.
- Encourage compliance with Federal, State, and local regulatory mechanisms designed to conserve fishery resources, maintain water quality, and protect aquatic habitat.
- Counties will continue to consider recovery needs of salmon and trout in comprehensive land-use planning processes.
- Provide information to the public on the importance of "healthy"[114] streams and the potential effects of land and water management activities on the habitat requirements of listed species.[115]
- Until recovery is achieved, improve or streamline the permitting process for conducting research and monitoring on ESA-listed species and for implementing restoration actions.
- Develop, maintain, and provide a comprehensive inventory of habitat projects and their costs and benefits (effectiveness) to the public annually.

Research and Monitoring Objectives

- Monitor the effectiveness of each "class" of habitat action implemented in the Upper Columbia Basin on listed species and community structure.[116]

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[114] "Healthy" is a relative term and is used in this plan to mean the habitat conditions necessary to sustain the listed species indefinitely.

[115] This action should include various workshops and seminars to increase the publics understanding of the ecology of the species and their habitat requirements.

[116] Despite a large body of knowledge about the habitat needs of fish, there still are uncertainties about which actions will be most effective. The intent of this plan is to make the best possible choice of actions based on available information and monitoring results, and modify actions as necessary.

- Accurately monitor trends in VSP parameters (including smolts/redd) at the population and subpopulation scale.
- Assess stream flows (within the natural hydrologic regime and existing water rights) suitable for spawning, rearing, and migration (based on current research and modeling).
- Implement current monitoring protocols and continue to develop standardized monitoring methods.
- Examine relationships between habitat and biological (including VSP) parameters at coarse (landscape) and fine (stream segment) scales.
- Update, revise, and refine watershed and salmonid performance assessment tools (e.g., EDT) to adaptively manage the implementation and prioritization strategy.
- Examine the effects of exotics species on listed species.
- Assess abundance and consumption rates of exotic fish that feed on listed species.
- Conduct channel migration studies within each subbasin to identify priority locations for protection and restoration.
- Examine fluvial geomorphic processes within each subbasin to assess how these processes affect habitat creation and loss.
- Inventory and assess fish passage barriers and screens within each subbasin.
- Conduct hydrologic assessments to better understand water balance and surface/groundwater relations within the subbasins.[117]

5.5.4 Recent Habitat Actions

Recent changes in land and water use practices on public and private lands are improving habitat conditions in the Upper Columbia Basin.[118] For example, the counties continue to protect and restore critical areas, including salmon and trout habitat through the Growth Management Act and the Shoreline Management Act and their associated administrative codes and local land-use regulations. Private landowners have proactively implemented many habitat restoration, conservation, and enhancement activities voluntarily (outside of planning processes) and many local stakeholders are involved in local planning efforts. The Forest Service, the largest land manager in the Upper Columbia Basin, manages spawning and rearing streams through several programs including the Northwest Forest Plan and the PACFISH/INFISH strategy. WDFW and the Department of Natural Resources also own land in the Upper Columbia Basin and have modified and continue to modify land management practices to improve habitat conditions. The tribes are also involved in habitat management and restoration. In sum, this plan recognizes that there are many areas within the subbasins of the Upper Columbia where good stewardship is

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[117] This includes studies that assess the effects of various activities that recharge aquifers that feed surface waters.
[118] In many cases the effects of these changes on environmental indicators and population VSP parameters are not clearly known.

occurring. This plan recommends that these efforts continue and that adequate funding is made available.

Table 5.8 provides a summary of habitat actions implemented within the last decade within each subbasin (excluding projects in Canada) and the mainstem Upper Columbia River and its smaller tributaries. This information was compiled from subbasin planning inventories and the Salmon Recovery Funding Board database, and categorized according to action type: acquisitions (land); assessments; passage improvements; habitat improvements; planning processes; research, monitoring, and evaluation (RME); screening; water quality; and water quantity. Undoubtedly, some projects were missed and about 20 projects could not be categorized. Several of the projects consisted of more than one action. For example, a given culvert/barrier removal project often addressed multiple culverts and barriers.

This inventory indicates that about 362 projects have been implemented within the Upper Columbia Basin within the past decade. There were at least 75 projects implemented within the Wenatchee subbasin, 69 in the Entiat, 145 in the Methow, 42 in the Okanogan, and 31 within the mainstem Upper Columbia and its smaller tributaries. These projects were implemented primarily by local entities, such as conservation and irrigation districts, with federal, state, and local government involvement.

5.5.5 Habitat Recovery Actions

This plan strengthens the likelihood that all actions and mitigation associated with habitat throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

Approach

This plan recognizes two general types of habitat recovery actions: restoration and protection. As noted earlier, this plan defines habitat restoration as a process that involves management decisions and actions that enhance the rate of recovery of habitat conditions (after Davis et al. 1984). The goal is to reestablish the ability of the ecosystem to maintain its function and organization without continued human intervention. It does not mandate or even suggest returning to an historical condition (often identified as an hypothesized prior state). In fact, restoration to a previous condition may not be possible (NRC 1992, 1996). Habitat protection, on the other hand, includes the use of management decisions and actions to safeguard ecosystem function and required habitat features of listed species. Protection includes all actions (not just regulatory) that protect habitat conditions.

This plan considered two forms of protection: no-net-impact and passive restoration. No-net-impact protection means that (1) activities that can harm stream and riparian structure and function will not occur, or (2) activities that harm stream and riparian habitat are mitigated by restoring and protecting an “equal or greater” amount of habitat. This type of protection is generally applied to areas where increased development is likely to occur.[119] The second type of

[119] This type of protection can only be met if better standards are implemented and enforced. At this time there are institutional and social problems with improving the standards. Although NNI protection is unlikely to occur, this form of protection was included in habitat modeling.

protection, passive restoration, addresses areas that are already protected under state and federal ownership. This also includes landowners that voluntarily protect stream and riparian conditions on their properties. Under this form of protection, habitat conditions improve as management actions are designed to maintain or improve habitat forming processes.

Habitat recovery actions identified in this plan were selected based on information contained in watershed plans (under RCW 90.82), subbasin plans, the Biological Strategy, Bull Trout Draft Recovery Plan, EDT results, empirical and derived data, and local knowledge and professional judgment[120]. The process of selecting actions began by dividing each subbasin into geographic assessment units, following watershed plans and subbasin plans. Within each assessment unit, the "primary" limiting factors and causal factors or threats were identified using information contained in watershed plans, subbasin plans, the Biological Strategy, the Bull Trout Draft Recovery Plan, and EDT results. The plan then identified species and life-stage specific management objectives. Here the intent was to identify the specific life-stages and species that would benefit from addressing the primary threats within an assessment unit.

Following the identification of specific management objectives, the plan identified "classes" of restoration actions (**Table 5.9**) that addressed each objective and linked directly to "primary" limiting factors/threats.[121] Restoration classes were identified through a collaborative process that included federal, state, and local governments, tribes, and local stakeholder participation. This plan identified suites of "specific" actions for each restoration class. It does ***not***, at this time, identify which of those specific actions will be implemented within each assessment unit, nor does it identify "specific" locations within the assessment unit where an action will be implemented.[122] Rather, this plan provides a short list of specific actions that ***could*** be implemented within each restoration class (**Table 5.9**). The plan does identify the appropriate restoration classes that are needed to address the primary limiting factors and threats within assessment units.

This plan recommends that local habitat groups[123] (see Section 5.5.6) recommend appropriate specific actions from the list of actions within each restoration class. These groups are also responsible for identifying the most appropriate places to implement the actions within the assessment units. This plan recommends that these groups implement actions that will result in changes to salmon and trout performance measures (at the population scale) that are at least as

[120] The use of professional judgment was not a haphazard approach at identifying recovery actions. Professional judgment required an indepth understanding of life-stage specific habitat requirements of the listed species and an understanding of current habitat conditions within the subbasins.
[121] This plan only identifies actions for the primary limiting factors. It does not identify actions for secondary limiting factors. Although secondary factors may limit VSP parameters of listed species, their effects are not well understood. Therefore, research actions will be identified to assess the effects of secondary factors on VSP parameters of listed species.
[122] In some areas (e.g., Wenatchee, Entiat, and Foster/Moses Coulee), Watershed Planning Groups are currently identifying and prioritizing "specific" actions within assessment units.
[123] A local habitat group exists or will be established within each of the five subbasins. As described later in this plan, these local groups will be responsible for recommending specific actions, overseeing implementation and monitoring of actions, and coordinating activities within their respective subbasin. Membership within each group is described in Section 5.5.6.

effective as the minimum restoration intensity modeled with EDT in this plan (33% intensity) (Appendix F). The 33% intensity was based on professional judgment and represented the minimum-effort scenario in EDT modeling and may not reflect what is feasible in each assessment unit. This plan anticipates that some restoration classes will be implemented at a higher intensity (e.g., 100%), while other (because of cost and feasibility) will be implemented at a lower intensity. Because not all restoration classes have the same effect on fish performance (e.g., riparian restoration has a different effect on fish performance than does water quality restoration), additional modeling, coupled with long-term monitoring, will be required to determine if the list of specific actions and intensities recommended by the local habitat groups result in equivalent potential increases in fish performance.

The final step in identifying habitat recovery actions was to assess the effects of habitat actions on the VSP parameters for spring Chinook, steelhead, and bull trout. Here the purpose was to link habitat restoration classes with specific VSP parameters. To simplify the process, the plan combined abundance and productivity (A/P) and spatial structure and diversity (SS/D) following the logic in Section 4.2.5. For each VSP parameter (A/P and SS/D) the plan determined if the implementation of an action class would have a large effect (X) or small effect (x) on the VSP parameters. Additionally, this plan integrated across the actions by comparing EDT results to VSP parameters (Appendix F). This process was informed by the known habitat requirements of the listed species and the known effects of habitat actions on the habitat requirements of the species (***sensu*** Gore 1985; Meehan 1991; Colt and White 1991; Hunter 1991; NRC 1992; Cowx 1994; Benaka 1999; Wissmar and Bisson 2003). In addition, the plan identified the amount of time (effect time) it would take for a given action to result in a change in a VSP parameter. Effect time was designated as short (1-5 years), medium (6-20 years), or long (>20 years). For example, providing passage into a stream historically used by a listed species should have a short effect time, while restoring riparian vegetation should have a long effect time.

The results of this work are summarized in Appendix G. The tables in Appendix G were organized by subbasin (a different table for each subbasin) and by geographic assessment unit (the first column in each table). Each table identifies the primary limiting factor(s) by assessment unit, the primary causal factors or threats, the management objectives, appropriate restoration classes (from **Table 5.9**), specific restoration actions (from **Table 5.9**), species affected by the action (spring Chinook, steelhead, or bull trout), contribution of the action to VSP (A/P or SS/D), and effect time. Assessment units were also ranked according to their importance to recovery (see Prioritization section below). At this time, the tables do not reflect feasibility of implementing habitat actions.

Prioritization

This plan provides the local habitat groups with a framework for prioritizing specific habitat actions. The framework is described in detail in Section 8.3. Briefly, the selection of specific actions is based on a balance between the biological benefit of the specific action and the cost and feasibility of implementing the action. Specific actions that provide a large benefit to the species and are relatively inexpensive and feasible to implement would have a higher rating than an action that has a lower biological benefit and is expensive and less feasible to implement. Because the Upper Columbia Region is highly dependent economically on agriculture, it is important that the agricultural community support the actions identified in this plan. Thus, the framework for selecting specific actions is a collaborative process, including managers, scientists, and local stakeholders. This approach has been demonstrated by the successful Entiat collaboration.

It is important to note that prioritization is simply a sequencing of actions or areas to be treated. It does not mean that actions or areas ranked as low priority will not be addressed. All classes of actions identified in Appendix G must be addressed, but because of limited annual resources, the plan must develop a method for selecting areas and actions that should be addressed first.

It is important to prioritize both the actions that will be implemented and the locations (assessment units) to be treated. The following framework for prioritizing and sequencing includes elements from watershed plans, subbasin plans, the Upper Columbia Biological Strategy, the Washington State Salmon Recovery Funding Board, and the Oregon Watershed Enhancement Board. These approaches are science-based, but also include federal, state, local government, and tribal goals and socio-economic concerns.

Categories of Actions within Subbasins

The first step in prioritizing recovery actions was to characterize the assessment units according to their contribution to recovery. In this plan, assessment units that are relatively undisturbed and provide "healthy" ecosystems were ranked highest. The intent is to protect these areas from activities that would negatively affect the structure and function of the aquatic and riparian ecosystems. Disturbance in these areas could preclude recovery or worse increase the probability of extinction. Of the assessment units in need of restoration, those that have the greatest potential for habitat improvement and recovery of multiple listed species were ranked higher than those that provide little benefit to the species.[124] Thus, this plan does not necessarily attempt to restore the degraded or most visibly altered areas, unless they will contribute significantly to VSP parameters.

The Biological Strategy (Appendix H) prepared by the UCRTT (2003) provided a useful framework for prioritizing assessment units across varied landscapes. The strategy identified four categories,[125] based on the functionality of the aquatic ecosystem and the resilience and resistance of ecosystems to disturbance. Category 1 areas were ranked highest. This does not mean that specific actions should not occur in Category 2, 3, and 4 areas until all activities in Category 1 areas are complete. Any action within Categories 2, 3, and 4 that increase the abundance, productivity, spatial structure, or diversity of listed species is encouraged and should contribute to recovery. The Biological Strategy described the categories as follows:

- ***Category 1 (Protection/Restoration)***: These areas represent systems that most closely resemble natural, fully functional aquatic ecosystems. They comprise large, connected blocks of high-quality habitat that support more than two listed species. Exotic species may be

[124] The same unit may be recommended for both protection and restoration. This may occur because (1) an areas may be both important to the protection of an existing population and possess substantial unrealized production potential, and (2) all priority restoration areas are automatically recommended for protection in order to keep from further degrading the reach before restoration can take place and to protect its newly enhanced condition once it is restored.
[125] The UCRTT also identified a fifth category that only addressed the mainstem Columbia River.

present but are not dominant in abundance. Protecting these areas is a priority, although restoration in some areas is also needed.

- ***Category 2 (Restoration/Protection)***: These areas support important aquatic resources and are strongholds for one or more listed species. Compared to Category 1 areas, Category 2 areas have a higher level of fragmentation resulting from habitat disturbance or loss. These areas have a large number of subwatersheds where native populations have been lost or are at risk for a variety of reasons. Restoring ecosystem function and connectivity within these areas are priorities.
- ***Category 3 (Restoration)***: These areas may still contain subwatersheds that support salmonids, but they have experienced substantial degradation and are strongly fragmented by habitat loss, especially through loss of connectivity with the mainstem corridor. The priority in these areas is to rectify the primary factors that cause habitat degradation.
- ***Category 4 (Major Restoration or Minor Fish Use)***: These areas contain both functional and non-functional habitat that historically supported one or more listed species. Exotic species are numerically dominant in one or more subwatersheds. Native species are generally not present in sustainable numbers. Restoration of these areas is important, but it should not hinder restoration in the other categories.

This plan adopted the framework outlined in the Biological Strategy. The rating of the assessment units within each subbasin are shown in **Table 5.10**. Note that there are no Category 1 assessment units in the Okanogan subbasin. This is primarily because the Okanogan currently supports only one listed species. As noted earlier, the fact that there are only Category 2, 3, and 4 areas in the Okanogan does not mean that they receive fewer resources than Category 1 areas in other subbasins. Indeed, the recovery of Okanogan steelhead is required before the DPS can be de-listed. However, to the extent possible, allocating resources for habitat actions in the Okanogan subbasin should follow the sequencing of categories identified in **Table 5.10**.

Small tributaries that drain directly into the mainstem Columbia River do not clearly fit within any of the categories identified in the Biological Strategy.[126] Nevertheless, this plan identifies restoration and protection measures for these streams.

Categorize Habitat Classes and Actions

The second step was to prioritize habitat classes and actions within assessment units based on biological benefits and socioeconomic considerations. As a general rule, the highest priority is to maintain and protect all areas within an assessment unit that are currently functioning properly (i.e., they have high biological integrity, connectivity, and habitat diversity) (Doppelt et al. 1993; Williams et al. 1997). Activities within these areas that can reduce the structure and function of riparian and aquatic ecosystems should be avoided or mitigated to prevent the species from slipping into a higher risk of extinction. Protecting existing riparian areas and stream flows within assessment units allows stream migration, which improves riparian and floodplain structure and function and increases habitat diversity and complexity.

[126] It was not an objective of the Biological Strategy to rate small tributaries the drain into the mainstem Columbia River. Therefore the Strategy did not create a category for them.

After implementing protection measures, it is important to categorize habitat restoration "classes" within assessment units. Emphasis is placed on actions with long persistence times (long life span) and benefits distributed over the widest range of environmental attributes (e.g., riparian restoration reduces stream temperatures, increases large woody debris recruitment, and increases habitat diversity and channel stability). However, this plan recognizes that restoration in some locations requires immediate measures in addition to long-term actions. These immediate actions are intended to "jump start" recovery in areas where reversing the cause of habitat degradation requires a long time to achieve. Immediate actions include such things as manual addition of large woody debris or instream structures to stream channels. Ultimately, this plan recommends that all restoration classes identified in Appendix G should be implemented.

Finally, after identifying restoration classes within an assessment unit, "specific" habitat actions must be selected for implementation. As noted earlier, this plan does not identify "specific" habitat actions that will be implemented within each assessment unit. Rather it provides a non-inclusive list of specific actions that could be implemented within an assessment unit to address primary limiting factors. It is the responsibility of the local habitat groups that are most familiar with the assessment units to recommend the most appropriate habitat actions.

Habitat Modeling

This plan used EDT to assess the relative effects of implementing the restoration classes identified in Appendix G on the performance of spring Chinook and steelhead within each subbasin. EDT was not used to assess the effects of restoration classes on bull trout performance, nor was it used to assess effects in small tributaries to the Columbia River or in the Entiat for steelhead. Bull trout modeling will be conducted in the future. However, habitat actions that benefit spring Chinook and steelhead will likely benefit bull trout. ***Importantly, in this plan, EDT was used only as a planning tool; it will not be used to determine when a population has been "recovered***." Described below is a brief summary of model setup and scenario runs. A more detailed description of procedures and assumptions used in EDT modeling is presented in Appendix F.

EDT was used to integrate across all restoration classes; however, the integration results were only quantified at two implementation intensities (100% and 33%) to provide some guidance on possible increases in fish performance. Thus, this plan reports only two different habitat scenarios (Scenarios 1 and 3) for spring Chinook and steelhead within the Wenatchee and Methow subbasins and for steelhead in the Okanogan subbasin. EDT results for Entiat spring Chinook were contained in the Entiat EDT Watershed Analysis (Mobrand Biometrics, Inc. 2003) and the Entiat WRIA 46 Management Plan (CCCD 2004).

- ***Habitat Scenario 1*** assumed that all restoration classes identified in Appendix G would be implemented at full intensity.[127] **<u>Full intensity in all assessment units is not feasible or practical, because it does not consider socioeconomic factors.</u> <u>This scenario is useful for planning purposes because it provides an upper bound on the relative benefits of implementing habitat restoration actions at maximum effort (full intensity) within each subbasin.</u>** If recovery cannot be achieved by implementing habitat actions at full intensity,

[127] This scenario did not consider potential effects from future development (see Appendix F).

then the contribution of other Hs (Harvest, Hatcheries, and Hydropower) and out-of-basin effects must be considered in recovery planning (this plan appropriately addresses recovery actions within all Hs).

- ***Habitat Scenario 2*** was not available in time for modeling purposes. Our vision was for scenario 2 to be the chosen mix and match of action classes and intensities that were feasible in each assessment unit, based on detailed local input regarding feasibility. We left an un-modeled scenario 2 in the report to emphasize the need for subwatershed specific prescriptions of each action class. It is assumed that Scenario 2 would fall somewhere in between scenarios 1 and 3.

- ***Habitat Scenario 3*** assumed that restoration classes identified in Appendix G would be implemented at 33% intensity (see footnote 126). Obstructions and protection were modeled at full intensity. Scenario 3 assumed that all artificial obstructions would be fixed and maintained. This scenario provided an alternative level of effort without making judgments about where high and low intensities were feasible and practical. Like scenario 1, this scenario did not consider socioeconomic factors. The plan assumes that this scenario represents a lower bounds on habitat restoration actions in the subbasins and would require a greater level of recovery contributions from the other Hs and in areas out-of-basin.

The model was set up so that it would provide results for each Scenario, plus current (without harvest) and “historical” conditions (Appendix F). The “historical” condition, referred to as the “Habitat Template” in EDT, represents estimated historical habitat conditions and current Columbia River mainstem conditions. The “True Template” in EDT refers to historic habitat conditions and historic mainstem conditions (without dams). Although the Habitat Template does not represent a “true” historical condition, both it and the “current” condition provide benchmarks for comparing the results of different scenarios.

EDT provided results in terms of fish “performance.” In EDT, performance was measured as relative changes in population abundance, productivity, capacity, and diversity index (Appendix F). Only abundance could be compared directly to the VSP parameters used in this plan. Productivity from EDT could not be compared directly to productivity used in this plan because EDT and viability curves relied on different stock-recruitment functions (see Appendix F). The diversity index in EDT could not be compared directly to the spatial structure and diversity parameters used in this plan, although the diversity index in EDT should correlate with some of the metrics used in evaluating spatial structure and diversity. Importantly, EDT did not consider genetic variation and the possible effects of hatchery fish on spawning grounds. These factors are important components of population diversity as described in this plan.

Because of uncertainties associated with some of the assumptions in the model and the lack of direct comparisons between most EDT performance metrics and VSP parameters, this plan avoided using EDT output as a predictor of “absolute” change. Rather, this plan used the results of EDT as an ***indicator*** of the potential change based on relative increases over current conditions and the proportion of within-subbasin potential that could be realized under two different scenarios (Appendix F).

Recovery Actions

The recovery actions listed below for each population are intended to reduce threats associated with land and water management activities in the Upper Columbia Basin. These actions address primary threats associated with population abundance, productivity, spatial structure, and diversity. Because maintaining existing water rights are important to the economy of landowners within the Upper Columbia Basin, this plan will not ask individuals or organizations to affect their water rights without empirical evidence as to the need for the recovery of listed species. To the extent allowed by law, landowners will be adequately compensated for implementing recovery actions. In addition, any land acquisition proposals in this plan will be based on the concept of no net loss of private property ownership, such as conservation easements, transfer of development rights, and other innovative approaches. Local habitat groups (in cooperation with local landowners) will prioritize and coordinate the implementation of "specific" habitat actions within assessment units.

Wenatchee Populations

The Wenatchee subbasin supports three listed species: spring Chinook, steelhead, and bull trout. Several factors, including activities driven by government policies have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many stream reaches in the Wenatchee subbasin. However, the subbasin contains headwater areas that are in relatively pristine condition and serve as "strongholds" for listed species. The following actions are intended to reduce the primary threats to aquatic and riparian habitats and to improve conditions where feasible and practical.

Short-term Protection Actions

Use administrative and institutional rules and regulations to protect and restore stream and riparian habitats on public lands within the following assessment units:

- Middle Wenatchee
- Upper Wenatchee
- Upper Icicle Creek
- Chiwaukum
- Chiwawa River
- Lake Wenatchee
- Little Wenatchee
- White River

Short-term Restoration Actions

Implement the following actions throughout the entire Wenatchee subbasin:

- Address passage barriers.
- Address diversion screens.

- Reduce the abundance and distribution of brook trout through feasible means (e.g., increased harvest).

White River Assessment Unit (Category 1; Appendix G.1):

- Increase habitat diversity within the lower 2 miles of the White River by reconnecting the floodplain and wetlands to the river.

Little Wenatchee Assessment Unit (Category 1; Appendix G.1):

- Reduce sediment recruitment to the stream by improving road maintenance within the watershed.

Chiwawa River Assessment Unit (Category 1; Appendix G.1):

- Increase habitat quantity by restoring riparian habitat along the lower 4 miles of the Chiwawa River.
- Reduce sediment recruitment to the stream by improving road maintenance within the watershed.
- Improve fish passage in tributaries.

Upper Wenatchee Assessment Unit (Category 1; Appendix G.1):

- Increase habitat quantity in the Wenatchee River between Tumwater Canyon and Lake Wenatchee by restoring riparian habitat along the river and reconnecting side channels (where feasible).

Nason Creek Assessment Unit (Category 2; Appendix G.1):

- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts).
- Increase habitat diversity and natural channel stability by increasing in-channel large wood complexes, restoring riparian habitat, and reconnecting side channels, wetlands, and floodplains to the stream.
- Improve road maintenance to reduce fine sediment recruitment to the stream.
- Reduce high water temperatures by reconnecting side channels and the floodplain and improving riparian habitat conditions.

Chiwaukum Creek Assessment Unit (Category 2; Appendix G.1):

- Increase connectivity along Skinney Creek.
- Increase habitat diversity in Chiwaukum Creek along Tumwater Campground by restoring riparian vegetation, reconnecting the floodplain with the stream, and by increasing large woody debris within the channel.

Lower Icicle Creek Assessment Unit (Category 2; Appendix G.1):

- Increase connectivity by improving fish passage over Dam 5 in the lower Icicle Creek.[128]
- Reduce sediment recruitment by restoring riparian vegetation between the mouth of the Icicle and the boulder field (RM 0-5.4).
- Improve road maintenance to reduce fine sediment recruitment in the upper watershed.
- Increase habitat diversity and quantity by restoring riparian vegetation, reconnecting side channels, and reconnecting the floodplain with the channel in lower Icicle Creek.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in Icicle Creek.

Peshastin Creek Assessment Unit (Category 2; Appendix G.1):

- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in Peshastin Creek.
- Reduce water temperatures by increasing stream flows and restoring riparian vegetation along the stream.
- Increase habitat diversity and quantity by restoring riparian vegetation, adding instream structures and large woody debris,[129] and reconnecting side channels and the floodplain with the stream.

Lower Wenatchee Assessment Unit (Category 2; Appendix G.1):

- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Wenatchee River.
- Reduce water temperatures by restoring riparian vegetation along the river.[130]
- Increase habitat diversity and quantity by restoring riparian habitat along the Wenatchee River, reconnecting side channels and the floodplain with the river, and increasing large woody debris in the side channels.

Mission Creek Assessment Unit (Category 3; Appendix G.1):

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[128] Action is necessary to improve passage for steelhead and bull trout. Preclude passage of out-of-basin fish (Carson stock).

[129] These actions are appropriate in the stream where the existing highway precludes restoration of riparian habitat and off-channel conditions.

[130] Both water quality and quantity will improve in the lower Wenatchee River as restoration actions are implemented throughout the subbasin.

- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in Mission Creek.
- Decrease water temperatures and improve water quality by restoring riparian vegetation along the stream.
- Reduce unnatural sediment recruitment to the stream by restoring riparian habitat and improving road maintenance.
- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and the floodplain with the channel, increasing large woody debris within the channel, and by adding instream structures.

Chumstick Creek Assessment Unit (Category 3; Appendix G.1):

- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in Chumstick Creek.
- Decrease water temperatures and improve water quality by restoring riparian vegetation along the stream.
- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and the floodplain with the channel, increasing large woody debris within the channel, and by adding instream structures.

Long-term Actions

- Protect and maintain stream and riparian habitats within Category 1 assessment units.
- Protect, maintain, or enhance beneficial stream and riparian habitat conditions established by implementing Short-term Actions within assessment units.
- Where feasible and practical, maintain connectivity throughout the historical distribution of the species.

Administrative/Institutional Actions

- The Wenatchee Habitat Group (in cooperation with local landowners) will prioritize and coordinate the implementation of “specific” habitat actions within assessment units.
- Revision of the Okanogan and Wenatchee National Forest Plan should compliment salmon, steelhead, and bull trout recovery.
- Local governments within Chelan County will review and adopt changes to comprehensive plans and ordinances for critical areas and shoreline master programs following the rules and dates set forth by the state legislature.

- Chelan County will evaluate local programs identified in (Appendix D) through processes such as stormwater plans.
- NOAA Fisheries, U.S. Fish and Wildlife Service, and the Army Corp of Engineers will improve the permitting process for projects specific to recovery actions by reducing the time, cost, and review process requirements.
- State agencies will improve the permitting process for projects specific to recovery actions by reducing the time, cost, and review process requirements.
- Federal and state agencies will improve their review of projects with the local governments, or permitted through local governments, in a timely manner as they pertain to various aspects of species recovery.
- Federal and state agencies shall improve permitting processes by implementing programmatic consultations for actions related to the implementation of this recovery plan.

Research and Monitoring Actions

- Monitor the effectiveness of at least three replicates of each restoration class implemented in the Wenatchee subbasin.
- Monitor trends in species abundance (redds, smolts, and adults) and distribution at the population and assessment unit scale.
- Monitor fish passage at Dryden and Tumwater dams.
- Evaluate fish passage at the boulder field in Icicle Creek.
- Examine relationships between VSP parameters and habitat conditions at coarse (landscape) and fine (stream segment) scales.
- Update baseline model runs as new and better information becomes available and conduct the scenario model run for the preferred alternative (Scenario 2) in each subbasin.
- Test assumptions and sensitivities of EDT model runs.
- Conduct hydrologic assessments to understand water balance and surface/groundwater relations within the Wenatchee subbasin.
- Continue channel migration studies in the Wenatchee subbasin.
- Assess the interaction of bull trout and sockeye salmon.
- Experiment with the use of different eradication methods for removing brook trout in areas with high densities of brook trout (upper Little Wenatchee, Big Meadow Creek, Minnow Creek, Schafer Lake, etc.).
- Assess the effects of brook trout harvest on survival of listed species.
- Examine fluvial geomorphic processes within the Wenatchee subbasin.

- Assess the contribution of small Columbia River tributaries downstream from the Wenatchee subbasin (e.g., Squilchuck, Stemilt, Colockum, Tarpiscan, Tekison, Quilomene/Brushy, and Trinidad/Lynch Coulee creeks) to Wenatchee steelhead abundance and productivity.

Expected Results

Wenatchee Spring Chinook: EDT and professional judgment were used to assess the potential contribution of habitat action classes in meeting VSP criteria. EDT predicted that under Scenarios 3 (33% intensity) and 1 (100% intensity), relative spring Chinook abundance should increase about 56% and 69%, respectively (**Figure 5.1**; Appendix F). EDT estimated relative productivity increases of 8% and 12% for Scenarios 3 and 1, respectively. Although these results indicate relative improvements in abundance and productivity, implementation of habitat classes within the Wenatchee subbasin will probably not meet minimum abundance and productivity criteria. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. In conclusion, these results indicate that (1) it is critically important to protect existing habitat in the upper watershed; (2) although relatively small benefits in abundance and productivity may be realized by improving habitat conditions in degraded assessment units downstream from Tumwater Canyon, these areas are important for spatial structure and diversity in VSP risk assessments; and (3) recovery of Wenatchee spring Chinook will require integration of habitat actions with other Hs and actions implemented outside the ESU.

Wenatchee Steelhead: EDT and professional judgment were used to assess the potential contribution of habitat action classes in meeting VSP criteria. EDT predicted that under Scenarios 3 (33% intensity) and 1 (100% intensity), relative steelhead abundance should increase about 89% and 102%, respectively (**Figure 5.2**; Appendix F). EDT estimated relative productivity increases of 14% and 16% for Scenarios 3 and 1, respectively. Although these results indicate relative improvements in abundance and productivity, implementation of habitat classes within the Wenatchee subbasin will probably not meet minimum abundance and productivity criteria. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. These results indicate that (1) it is critically important to protect existing habitat in the upper watershed as well as mainstem Wenatchee rearing habitat; (2) although relatively small benefits in abundance and productivity may be realized by improving habitat conditions in degraded assessment units downstream from Tumwater Canyon, these areas are important for spatial structure and diversity in VSP risk assessments; and (3) recovery of Wenatchee steelhead will require integration of habitat actions with other Hs and actions implemented outside the DPS.

Entiat Populations

The Entiat subbasin supports three listed species: spring Chinook, steelhead, and bull trout. Several factors, including activities driven by government policies have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many stream reaches in the Entiat subbasin. However, the subbasin contains headwater areas that are in relatively pristine condition and serve as “strongholds” for listed species. The following actions are intended to reduce the primary threats to aquatic and riparian habitats and to improve conditions where feasible and practical.

Short-term Protection Actions

Use administrative and institutional rules and regulations to protect and restore stream and riparian habitats on public lands within the following assessment units:

- Upper Entiat
- Middle Entiat
- Mad River

Short-term Restoration Actions

Implement the following actions throughout the entire Entiat subbasin:

- Address passage barriers.
- Address diversion screens.
- Manage fuels to represent/restore natural ecosystem profiles and implement Northwest Forest Plan and Entiat Community Wildfire Protection Plan.

Upper Entiat Assessment Unit (Category 1; Appendix G.2):

- Increase the harvest limit on brook trout.

Middle Entiat Assessment Unit (Category 1; Appendix G.2):

- Increase habitat diversity in the middle Entiat River by restoring riparian habitat and increasing large woody debris within the channel.
- Increase connectivity in Stormy Creek by replacing or improving culverts.

Mad River Assessment Unit (Category 1; Appendix G.2):

- Increase habitat diversity and quantity within the lower 4 miles of the Mad River by restoring riparian habitat, increasing large woody debris within the channel, adding instream structures (rock structures), and by improving road maintenance.

Lower Entiat Assessment Unit (Category 2; Appendix G.2):

- Increase habitat diversity and quantity in the lower Entiat by restoring riparian habitat, adding instream structures (rock "cross vane" structures or other structures), increasing large woody debris, and reconnecting side channels and the floodplain with the river.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Entiat River.

Long-term Actions

- Protect and maintain stream and riparian habitats within Category 1 assessment units.
- Protect, maintain, or enhance beneficial stream and riparian habitat conditions established by implementing Short-term Actions within assessment units.

- Where feasible and practical, maintain connectivity throughout the historical distribution of the species.

Administrative/Institutional Actions

- The Entiat Habitat Group (in cooperation with local landowners) will prioritize and coordinate the implementation of "specific" habitat actions within assessment units.
- Revision of the Okanogan and Wenatchee National Forest Plan should compliment salmon, steelhead, and bull trout recovery.
- Local governments within Chelan County will review and adopt changes to comprehensive plans and ordinances for critical areas and shoreline master programs following the rules and dates set forth by the state legislature.
- Chelan County will evaluate local programs identified in (Appendix D) through processes such as stormwater plans.
- NOAA Fisheries, U.S. Fish and Wildlife Service, and the Army Corp of Engineers will improve the permitting process for projects specific to recovery actions by reducing the time, cost, and review process requirements.
- Federal and state agencies will improve their review of projects with the local governments, or permitted through local governments, in a timely manner as they pertain to various aspects of species recovery.
- Federal and state agencies shall improve permitting processes by implementing programmatic consultations for actions related to the implementation of this recovery plan.

Research and Monitoring Actions

- Monitor the effectiveness of at least three replicates of each restoration class implemented in the Entiat subbasin.
- Monitor trends in species abundance (redds, smolts, and adults) and distribution at the population and assessment unit scale.
- Examine relationships between VSP parameters and habitat conditions at coarse (landscape) and fine (stream segment) scales.
- Update baseline model runs as new and better information becomes available and conduct the scenario model run for the preferred alternative (Scenario 2) in each subbasin.
- Test assumptions and sensitivities of EDT model runs.
- Examine the effects of nutrient enhancement on trophic structure in the Entiat subbasin.
- Conduct additional hydrologic assessments to understand water balance and surface/groundwater relations within the Entiat subbasin.
- Continue channel migration studies in the Entiat subbasin.
- Experiment with the use of different eradication methods for removing brook trout.

- Assess the effects of brook trout harvest on survival of listed species.
- Continue to examine fluvial geomorphic processes within the Entiat subbasin.
- Continue to assess the presence or absence of bull trout in the Upper Entiat assessment unit.

Expected Results

Entiat Spring Chinook: Mobrand Biometrics (2003) modeled the effects of five different management scenarios, which included various intensities of riparian, habitat diversity, and off-channel habitat restoration actions and protection measures. Based on the most intensive management scenario (Alternative 5 in Table 7-22 in CCCD 2004), EDT predicted that the relative increase in spring Chinook abundance would be about 36%, which probably will not meet the minimum recovery abundance of 500 naturally produced spring Chinook in the Entiat subbasin. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. These results indicate that (1) it is critically important to protect existing habitat in the upper watershed as well as mainstem Entiat rearing habitat; (2) a greater intensity of habitat actions may be needed in the Entiat subbasin, and (3) recovery of Entiat spring Chinook will require integration of habitat actions with other Hs and actions implemented outside the ESU.

Fish performance was not evaluated using scenario modeling for steelhead or bull trout in the Entiat watershed. However, considering the baseline current and historic model runs, the Entiat could not sustain an abundance of steelhead sufficient to meet VSP minimum abundance threshold under likely recovery scenarios. Future scenario modeling will be coordinated with the Entiat Watershed Group.

Methow Populations

The Methow subbasin supports three listed species: spring Chinook, steelhead, and bull trout. Several factors, including activities driven by government policies have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many stream reaches in the Methow subbasin. However, the subbasin contains headwater areas that are in relatively pristine condition and serve as “strongholds” for listed species. The following actions are intended to reduce the primary threats to aquatic and riparian habitats and to improve conditions where feasible and practical.

Short-term Protection Actions

Use administrative and institutional rules and regulations to protect and restore stream and riparian habitats on public lands within the following assessment units:

- Upper Chewuch
- Upper Twisp
- Upper Methow
- Early Winters Creek
- Lost River

- Upper Wolf

Short-term Restoration Actions

Implement the following actions throughout the entire Methow subbasin:

- Address passage barriers.
- Address diversion screens.
- Reduce the abundance and distribution of brook trout through feasible means (e.g., increased harvest).

Upper Methow/Early Winters/Lost Assessment Unit (Category 1; Appendix G.3):

- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the lower five miles of Early Winters Creek.
- Reduce sediment load by improving road maintenance along the lower portion of the upper Methow assessment unit and the lower Lost River.
- Increase habitat diversity and quantity by restoring riparian habitat and reconnecting side channels (where feasible) between Goat Creek and the Lost River.
- Increase habitat diversity by improving streambank conditions in the lower Lost River.
- Restore natural channel migration and alluvial fan forming processes on lower Early Winters Creek.

Upper Chewuch Assessment Unit (Category 1; Appendix G.3):

- Increase habitat diversity and quantity by restoring riparian habitat throughout the assessment unit.
- Reduce sediment load by improving road maintenance along the upper Chewuch River.

Upper Twisp Assessment Unit (Category 1; Appendix G.3):

- Increase habitat diversity and quantity in the upper Twisp by restoring riparian habitat and floodplain connectivity.
- Reduce sediment load by improving road maintenance throughout the assessment unit.

Lower Chewuch Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity in the lower Chewuch River between river miles 0 and 8 by restoring riparian habitat, reconnecting side channels and the floodplain, and adding instream structures.
- Reduce sediment load by improving road maintenance along the lower Chewuch River (actions in the upper Chewuch should also reduce sediment recruitment in the lower Chewuch).

- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Chewuch River.
- Decrease water temperatures in the lower Chewuch River by increasing riparian vegetation, increasing stream flows, and reconnecting side channels and the floodplain with the river.

Lower Twisp Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity in the lower Twisp River by restoring riparian habitat, reconnecting side channels and the floodplain (where feasible), and adding instream structures within the river.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Twisp River.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).

Upper-Middle Methow Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity in the upper-middle Methow by restoring riparian habitat and reconnecting side channels and the floodplain (where feasible).
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Methow River (addressed primarily through actions in upstream locations).

Middle Methow Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity in the middle Methow by restoring riparian habitat, reconnecting side channels and the floodplain (where feasible), and adding instream structures (low priority action) within the river.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Methow River.

Lower Methow Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity in the Methow River upstream from the town of Carlton by restoring riparian habitat and reconnecting the floodplain with the river.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the Methow River (addressed primarily through actions in upstream locations).

Wolf/Hancock Creek Assessment Unit (Category 2; Appendix G.3):

- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and floodplains (where feasible), and adding large woody debris and instream structures between river mile 1 and the spring in Hancock Creek.

Beaver/Bear Creek Assessment Unit (Category 3; Appendix G.3):

- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and floodplains (where feasible), and adding large woody debris and instream structures within the upper Beaver Creek and Bear Creek watersheds.
- Reduce sediment load by improving road maintenance along Beaver Creek.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the streams.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing diversions in the lower 8 miles of Beaver Creek and culverts upstream from river mile 8 on Beaver Creek.

Gold/Libby Creek Assessment Unit (Category 3; Appendix G.3):

- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and floodplains (where feasible), and adding large woody debris and instream structures within the streams.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the streams.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).

Goat/Little Boulder Creek Assessment Unit (Category 3; Appendix G.3):

- Increase habitat diversity and quantity in Goat Creek by restoring riparian habitat (river mile 0 to Vanderpool Crossing), reconnecting side channels and floodplains (where feasible), and adding large woody debris and instream structures between river mile 1.5 and Vanderpool Crossing.
- Reduce sediment load by improving road maintenance along Goat Creek downstream from Vanderpool Crossing.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in the streams.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (Highway 20 culvert).

Black Canyon/Squaw Creek Assessment Unit (Category 3; Appendix G.3):

- Increase habitat diversity and quantity by restoring riparian habitat, reconnecting side channels and floodplains (where feasible), and adding large woody debris and instream structures within the streams.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) in Black Canyon and Squaw Creek.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).

Long-term Actions

- Protect and maintain stream and riparian habitats within Category 1 assessment units.
- Protect, maintain, or enhance beneficial stream and riparian habitat conditions established by implementing Short-term Actions within assessment units.
- Where feasible and practical, maintain connectivity throughout the historical distribution of the species.

Administrative/Institutional Actions

- The Methow Habitat Group (in cooperation with local landowners) will prioritize and coordinate the implementation of “specific” habitat actions within assessment units.
- Revision of the Okanogan and Wenatchee National Forest Plan should compliment salmon, steelhead, and bull trout recovery.
- Local governments within Okanogan County will review and adopt changes to comprehensive plans and ordinances for critical areas and shoreline master programs following the rules and dates set forth by the state legislature.
- Okanogan County will evaluate local programs identified in (Appendix D) through processes such as stormwater plans.
- NOAA Fisheries, U.S. Fish and Wildlife Service, and the Army Corp of Engineers will improve the permitting process for projects specific to recovery actions by reducing the time, cost, and review process requirements.
- Federal and state agencies will improve their review of projects with the local governments, or permitted through local governments, in a timely manner as they pertain to various aspects of species recovery.
- Federal and state agencies shall improve permitting processes by implementing programmatic consultations for actions related to the implementation of this recovery plan.

Research and Monitoring Actions

- Monitor the effectiveness of at least three replicates of each restoration class implemented in the Methow subbasin.
- Monitor trends in species abundance (redds, smolts, and adults) and distribution at the population and assessment unit scale.
- Examine relationships between VSP parameters and habitat conditions at coarse (landscape) and fine (stream segment) scales.
- Update baseline model runs as new and better information becomes available and conduct the scenario model run for the preferred alternative (Scenario 2) in each subbasin.
- Test assumptions and sensitivities of EDT model runs.

- Conduct additional hydrologic assessments to understand water balance and surface/groundwater relations within the Methow subbasin.
- Conduct channel migration studies in the Methow subbasin.
- Assess the effects of brook trout harvest on survival of listed species.
- Examine fluvial geomorphic processes within the Methow subbasin.
- Assess the contribution of the Chelan River to Methow steelhead abundance and productivity.

Expected Results

Methow Spring Chinook: EDT and professional judgment were used to assess the potential contribution of habitat action classes in meeting VSP criteria. EDT predicted that under Scenarios 3 (33% intensity) and 1 (100% intensity), relative spring Chinook abundance should increase about 54% and 124%, respectively (**Figure 5.3**; Appendix F). EDT estimated relative productivity increases of 17% and 53% for Scenarios 3 and 1, respectively. Although these results indicate relative improvements in abundance and productivity, implementation of habitat classes within the Methow subbasin will probably not meet minimum abundance and productivity criteria. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. In conclusion, these results indicate that (1) it is critically important to protect existing habitat in the upper watershed; (2) relatively large improvements can be realized by restoring and protecting habitat in the Methow subbasin; and (3) recovery of Methow spring Chinook will require integration of habitat actions with other Hs and actions implemented outside the ESU.

Methow Steelhead: EDT and professional judgment were used to assess the potential contribution of habitat action classes in meeting VSP criteria. EDT predicted that under Scenarios 3 (33% intensity) and 1 (100% intensity), relative steelhead abundance should increase about 65% and 136%, respectively (**Figure 5.4**; Appendix F). EDT estimated relative productivity increases of 17% and 48% for Scenarios 3 and 1, respectively. Although these results indicate relative improvements in abundance and productivity, implementation of habitat classes within the Methow subbasin will probably not meet minimum abundance and productivity criteria. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. Therefore, these results indicate that (1) it is critically important to protect existing habitat in the upper watershed; (2) relatively large improvements can be realized by restoring and protecting habitat in the Methow subbasin; and (3) recovery of Methow steelhead will require integration of habitat actions with other Hs and actions implemented outside the DPS.

Okanogan Population

The Okanogan subbasin currently supports only one listed species, steelhead. The presence of bull trout remains unknown in the Okanogan subbasin. Several factors, including activities driven by government policies have reduced habitat diversity and quantity, connectivity, water quantity and quality, and riparian function in many stream reaches in the Okanogan subbasin. The following actions are intended to reduce the primary threats to aquatic and riparian habitats and to improve conditions where feasible and practical within the U.S. portion of the Okanogan subbasin.

Short-term Protection Actions

Use administrative and institutional rules and regulations to protect and restore stream and riparian habitats on public lands within the following assessment units:

- Upper Omak

Short-term Restoration Actions

Implement the following actions throughout the U.S. portion of the Okanogan subbasin:

- Address passage barriers.
- Address diversion screens.
- Increase harvest on exotic species (e.g., bass, walleye, etc.).

Lower Okanogan Assessment Unit (Category 2; Appendix G.4):

- Increase habitat diversity and quantity by restoring riparian habitat (throughout the assessment unit) and reconnecting side channels and the floodplain (near the confluence of Salmon Creek).
- Improve fish passage by screening irrigation diversions.
- Reduce summer water temperature in the lower Okanogan River by implementing actions in tributaries and upstream assessment units.

Middle Okanogan Assessment Unit (Category 2; Appendix G.4):

- Reduce summer water temperature and sediment recruitment in the middle Okanogan River by reconnecting side channels and the floodplain with the river.

Upper Okanogan Assessment Unit (Category 2; Appendix G.4):

- Increase habitat diversity and quantity by restoring riparian habitat along the river.
- Reduce summer water temperature and sediment recruitment in the upper Okanogan River by reconnecting side channels and the floodplain with the river.

Omak and Tributaries Assessment Unit (Category 2; Appendix G.4):

- Increase habitat diversity and quantity by restoring riparian habitat and adding large woody debris and instream structures within the streams.
- Reduce sediment load by improving road maintenance along Omak Creek (especially the upper watershed).
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).

Lower Salmon Creek Assessment Unit (Category 3; Appendix G.4):

- Use practical and feasible means (including reconnection of side channels and the floodplain with the stream) to increase stream flows (within the natural hydrologic regime and existing water rights) within the lower 4 miles of Salmon Creek.
- Improve fish passage throughout lower Salmon Creek downstream from Conconully Dam.
- Increase habitat diversity by channel reconfiguration in the lower 4 miles of Salmon Creek.

Similkameen Assessment Unit (Category 3; Appendix G.4):

- Improve water quality (heavy metals) and sediment recruitment by removing effects of mining activities upstream from Enloe Dam.

Loup Loup Creek Assessment Unit (Category 4; Appendix G.4):

- Increase habitat diversity and quantity by restoring riparian habitat and adding large woody debris and instream structures within the stream.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) within Loup Loup Creek.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).

Small Tributary Systems Assessment Unit (Category 4; Appendix G.4):

- Increase habitat diversity and quantity by restoring riparian habitat and adding large woody debris and instream structures within Bonaparte (to natural barriers), Tunk (to natural barriers), and Ninemile creeks.
- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers (culverts and diversions).
- Reduce sediment recruitment by improving roads particularly along Bonaparte Creek.
- Use practical and feasible means to increase stream flows (within the natural hydrologic regime and existing water rights) within tributaries.
- Work closely with Canadian biologists and managers to restore habitat conditions and increase connectivity in the Okanogan subbasin within Canada.

Long-term Actions

- Protect, maintain, or enhance beneficial stream and riparian habitat conditions established by implementing Short-term Actions within assessment units.
- Where feasible and practical, maintain connectivity throughout the historical distribution of the species.
- Work closely with Canadian managers and biologist to restore habitat conditions in the upper Okanogan subbasin.

Administrative/Institutional Actions

- The Okanogan Habitat Group (in cooperation with local landowners) will prioritize and coordinate the implementation of "specific" habitat actions within assessment units.
- Revision of the Okanogan and Wenatchee National Forest Plan should compliment salmon, steelhead, and bull trout recovery.
- Local governments within Okanogan County will review and adopt changes to comprehensive plans and ordinances for critical areas and shoreline master programs following the rules and dates set forth by the state legislature.
- Okanogan County will evaluate local programs identified in (Appendix D) through processes such as stormwater plans.
- NOAA Fisheries, U.S. Fish and Wildlife Service, and the Army Corp of Engineers will improve the permitting process for projects specific to recovery actions by reducing the time, cost, and review process requirements.
- Federal and state agencies will improve their review of projects with the local governments, or permitted through local governments, in a timely manner as they pertain to various aspects of species recovery.
- Federal and state agencies shall improve permitting processes by implementing programmatic consultations for actions related to the implementation of this recovery plan.

Research and Monitoring Actions

- Monitor the effectiveness of at least three replicates of each restoration class implemented in the Entiat subbasin.
- Monitor trends in species abundance (redds, smolts, and adults) and distribution at the population and assessment unit scale.
- Examine relationships between VSP parameters and habitat conditions at coarse (landscape) and fine (stream segment) scales.
- Investigate the effects of nutrient enrichment from development along Lake Osoyoos on fish community structure.
- Update baseline model runs as new and better information becomes available and conduct the scenario model run for the preferred alternative (Scenario 2) in each subbasin.
- Test assumptions and sensitivities of EDT model runs.
- Assess the abundance and consumption rates of exotic fish that feed on steelhead.
- Examine the feasibility of providing passage throughout upper Salmon Creek.
- Conduct hydrologic assessments to understand water balance and surface/groundwater relations within the Okanogan subbasin.
- Conduct channel migration studies in the Okanogan subbasin.

- Examine fluvial geomorphic processes within the Okanogan subbasin.
- Assess the presence or absence of bull trout in the Okanogan subbasin.
- Assess the contribution of Foster Creek to Okanogan steelhead abundance and productivity.

Expected Results

Okanogan Steelhead: EDT and professional judgment were used to assess the potential contribution of habitat action classes in meeting VSP criteria. EDT predicted that under Scenarios 3 (33% intensity) and 1 (100% intensity), relative steelhead abundance should increase about 281% and 377%, respectively (**Figure 5.5**; Appendix F). EDT estimated relative productivity increases of 49% and 66% for Scenarios 3 and 1, respectively. Although these results indicate relative improvements in abundance and productivity, implementation of habitat classes within the Okanogan subbasin will probably not meet minimum abundance and productivity criteria. On the other hand, these action classes are expected to meet spatial structure criteria and the diversity criteria that are related to habitat conditions and distribution. In conclusion, these results indicate that (1) relatively large improvements can be realized by restoring and protecting habitat in the U.S. portion of the Okanogan subbasin and (2) recovery of Okanogan steelhead will require integration of habitat actions with other Hs and actions implemented outside the DPS.

Crab Creek Population

The Crab Creek subbasin currently supports only one listed species, steelhead. As noted in Section 1.3.6, this plan does not specifically address recovery of the Crab Creek population. Recovery of the Upper Columbia steelhead DPS can be achieved without recovery of the Crab Creek population.

5.5.6 Responsible Parties

Membership within the Implementation Team will include tribes, local landowners, federal, state, local governments, and conservation districts responsible for implementing and monitoring habitat actions in the Upper Columbia Basin.

5.5.7 Coordination and Commitments

This plan assumes an Implementation Team will engage in discussions associated with habitat actions. This Team will be involved in all issues related to recovery actions, and will work within the framework of the Upper Columbia Salmon Recovery Board (UCSRB), HCPs for Chelan and Douglas PUDs, Grant PUD BiOp and Anadromous Fish Agreement, Section 7 consultations, and federal trust responsibilities to the tribes.

The Upper Columbia Basin already has a habitat technical team, known as the Upper Columbia Regional Technical Team (UCRTT) that was created by the UCSRB to recommend region-wide approaches to protect and restore salmonid habitat; develop and evaluate salmonid recovery projects; and develop, guide, and coordinate recovery monitoring plans. This plan recommends that the UCRTT serve as the habitat technical committee to the Implementation Team.

Local habitat groups will be responsible for identifying specific habitat restoration actions and coordinating activities within their respective subbasins. This plan recommends that these groups prioritize the implementation of specific actions following the strategy outlined in Section 8.0. All proposed habitat recovery actions will be coordinated with local stakeholder input and local stakeholders will be included in the development of any of the planning processes that may affect their interests. If necessary, the UCRTT could provide technical guidance and review to the local recovery groups.

The State of Washington (through the Salmon Recovery Funding Board), PUDs, Action Agencies (Bonneville Power Administration, Bureau of Reclamation, and Army Corps of Engineers), the Yakama Nation, the Colville Tribes, and various other Federal, State, and local agencies are funding and will continue to fund habitat actions in the Upper Columbia Basin. Habitat conservation plans, binding mitigation agreements, and biological opinions increase the likelihood that habitat restoration actions have funding and will continue operating into the future.

5.5.8 Compliance

Habitat actions are currently monitored through processes like the Upper Columbia Monitoring Strategy (Hillman 2004), Salmon Recovery Board, biological opinions, relicensing agreements, BPA and BOR programs, Colville Tribes monitoring program, U.S. Forest Service programs, DOE programs, and others. Under the guidance of the Upper Columbia Monitoring Strategy, adopted by the Upper Columbia Salmon Recovery Board, the UCRTT coordinates monitoring within the Upper Columbia Basin. This plan will rely on the Upper Columbia Monitoring Strategy (which is continually updated to incorporate new information) and the UCRTT to make sure that habitat recovery actions are implemented correctly, habitat actions are monitored for effectiveness,[131] and VSP parameters are measured and tracked over time to assess recovery of populations, the ESU, and the DPS.

5.6 Integration of Actions

At this time it is very difficult to assess the cumulative (sum) beneficial effects of actions across all sectors (Hs), because regionally accepted tools for adding effects across sectors are currently not available. Two investigational methods were used to estimate potential effects in this plan; a simple multiplicative approach and a modeling approach. Both approaches will be more fully developed in the future. These preliminary approaches and their results are described below. In this section the plan only addressed spring Chinook and steelhead. Methods used to assess cumulative beneficial effects on bull trout will be explored at a later date.

5.6.1 Multiplicative Approach

This approach used information from Sections 2, 3, and 5 to determine if the actions recommended within the plan are likely to achieve recovery. The simulation also used additional information and assumptions (which are outlined below) to evaluate the actions that have either been recently enacted, or recommended within the recovery plan. Below, we outline by sector the associated assumptions and information that were used to estimate the increase in productivity (survival).

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[131] The Upper Columbia Strategy does not require that all habitat actions be assessed for effectiveness. Rather, a random subset of actions from each habitat class will be monitored for effectiveness.

For all sectors, a 50% hatchery effectiveness (reproductive success) rate was assumed for steelhead. As such, the values for productivity reported here for steelhead differ from those reported in Section 2. [132] The run was reconstructed using 50% of the hatchery fish included with naturally produced fish to determine productivity values. The exercise calculated for all sectors a low and high potential increase in productivity. The lower and upper estimates were determined by modeling (e.g., EDT for habitat) or professional judgment. A more detailed discussion of this approach and preliminary results provided in Appendix I.

Harvest

As discussed in detail in Section 5.2 and in the Harvest Module (Appendix I), harvest on Upper Columbia steelhead and spring Chinook has been significantly reduced over the last several decades. As a result, there is little opportunity to reduce harvest rates beyond their current limits. The recovery actions identified in this Plan may result in a small reduction in harvest through improved management strategies, harvest methods, and marking techniques. Therefore, for the purposes of this exercise, the plan assumed a range of change in potential productivity from 0% (lower potential) to 1% (upper potential) (**Table 5.11**).

The plan also estimated potential survival benefits associated with terminating all harvest on spring Chinook and steelhead. The results indicated a potential increase of 9-10% in productivity of spring Chinook, but steelhead productivity actually decreased. The reason is because a large number of hatchery produced steelhead would escape to spawning grounds and "swamp" the spawning population. Hatchery produced steelhead currently have a lower reproductive success than naturally produced fish (the plan optimistically assumed a reproductive success of 0.5 for hatchery steelhead) and therefore would drive the productivity of the population down to low levels. Harvest on hatchery produced steelhead means fewer hatchery fish escape to spawning grounds. This results in a greater percentage of the spawning escapement consisting of naturally produced fish that are more productive than hatchery steelhead.

Hatcheries

The theoretical difference between the productivities for steelhead estimated in Section 2 was used to determine hatchery changes that contribute to productivity. The historical steelhead run was reconstructed using two different reproductive success scenarios for hatchery spawners: (1) hatchery spawners were as effective as wild spawners (100%; H = 1) and (2) hatchery spawners did not contribute to returning spawners at all (0%; H = 0).

In the Wenatchee and Entiat rivers[133], there is a 63% difference between zero contribution of hatchery spawners (return per spawner is 0.81) and 100% effectiveness (return per spawner is 0.25). In the Methow and Okanogan rivers the difference is 89% (0.89 if H = 0 and 0.09 for H = 1). Because no data currently exist in the Upper Columbia[134] to determine true hatchery spawner

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[132] Recall that in Section 2 steelhead productivity was estimated using hatchery effectiveness rates of 0% and 100%.

[133] Wenatchee-Entiat, and Methow-Okanogan returns per spawner cannot be separated because the base population (dam counts) is the same (see Appendix C for further details).

[134] There is currently a study underway to estimate spring Chinook hatchery spawner effectiveness in the Wenatchee River, and Chelan and Douglas PUDs will be determining the same for steelhead through their HCP hatchery M&E programs.

effectiveness, it was assumed in this exercise that hatchery spawners are half (50%; H = 0.5) as effective as naturally produced spawners for both steelhead and spring Chinook. It was also assumed that the relationship between 100% hatchery spawner effectiveness and 0% hatchery spawner effectiveness for steelhead applies to spring Chinook within the Wenatchee, Entiat, and Methow rivers.

In the absence of empirical data, improvements in hatchery practices may result in a 3-5% survival increase in naturally produced spring Chinook and steelhead in the Wenatchee-Entiat populations, and a 5-10% increase in the Methow-Okanogan populations (**Table 5.11**). The greater increase in the Methow-Okanogan populations reflects the recommended action of collecting local broodstock within tributaries rather than composite fish at Wells Dam. These survival changes also appear to be supported by AHA modeling results (see Appendix J).

Hydro Projects

The calculated increases in juvenile survival from the draft QAR (Cooney et al. 2000) were applied to the calculated geo-mean of returns per spawner from Section 2 for spring Chinook and steelhead. This was applied basin-specific, where applicable. The estimated increase in juvenile survival from Table 24 in Cooney et al. (2000) was used for all five PUD dams, and their estimated increase in juvenile survival in the lower Columbia River from McNary to downstream from Bonneville dam (14.5% improvement; Table 27 in Cooney et al. 2000, plus an additional improvement of 8% and 9% for steelhead and spring Chinook, respectively, based on long-term gains in the FCRPS) was also applied to the estimated increases from the HCPs on local hydro dams. This exercise assumed 1:1 increase in spawners from an increase in juvenile survival from the proposed actions (i.e., a 10% increase in juvenile survival resulted in a 10% increase in spawners). Based on this information, productivity could increase between 35-51% for spring Chinook populations and 30-40% for steelhead populations (**Table 5.11**). These estimates were used for both low and high productivity potentials.

Habitat

EDT results for the Wenatchee, Entiat[135], Methow, and Okanogan were used to determine what percent increase in productivity could be expected from implementing habitat actions recommended in the Plan. Density-independent survival changes as smolts per spawner were estimated across a range of spawner abundances less than 2,000 spawners, the minimum recovery abundance for large populations established by the ICBTRT. Because the extent to which the proposed habitat actions would be implemented was unknown, EDT modeled two different scenarios: (1) implementation intensity of 33% and (2) implementation intensity of 100% (See Appendix F). This provided a potential range of effects from recommended habitat actions. **<u>It is important to note that full intensity (100%) in all assessment units is not feasible or practical, because it does not consider socioeconomic factors.</u> <u>This scenario is useful for planning purposes because it provides an upper bound on the relative benefits of</u>**

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[135] In the Entiat, a different model run was used. Since the Entiat Watershed Plan has run EDT for various scenarios, we used their Scenario 5, as described in the Watershed Plan, and compared it to the "33%" run from the other subbasins. The Entiat Watershed Plan did not model steelhead and there has been no attempt to model steelhead in the Entiat.

implementing habitat restoration actions at maximum effort (full intensity) within each subbasin.

Under the 33% intensity scenario (lower potential), productivity of spring Chinook populations could increase 3-25% (**Table 5.11**). Under 100% intensity (upper potential), productivity of spring Chinook populations could increase 3-36% (**Table 5.11**). Productivity of Upper Columbia steelhead populations under the 33% scenario could increase 14-47%, while steelhead productivities under the 100% scenario could increase 31-64% (**Table 5.11**). Note that there is no estimate for Entiat steelhead because there was no EDT analysis completed for this population.

Integration across Sectors

To determine the total change in survival for each population, the changes in productivity (calculated as the ratio of proposed productivity to current productivity within a sector) were multiplied across sectors to estimate the total survival multiplier from the proposed actions. For Upper Columbia spring Chinook populations, survival could increase 99-137% under the lower potential productivity scenario to 107-198% under the higher potential productivity scenario (**Table 5.11**). Survival for steelhead populations could increase 85-178% under the low productivity scenario to 90-226% under the higher productivity scenario (**Table 5.11**).

5.6.2 Modeling Approach

All H Analyzer

The "All H Analyzer" (AHA), as used in this plan, describes the integration of in-basin and out-of-basin effects on salmon and steelhead. The analysis explains contributions of harvest, hatcheries, hydropower[136], and habitat data and strategies to recovery. The AHA process is an exercise that investigates (simulates) out-of-subbasin effects within the context of tributary habitat improvements.

AHA, as used in this planning exercise, simulates various recovery actions between in-basin and out-of-basin effects. This approach gives planners a means for evaluating various options. The different options include harvest regimes, modifications to existing hatchery programs, and habitat improvement actions. Listed below are preliminary results of the AHA analyses. These results provide only a relative assessment of the cumulative effects of actions among different sectors (Appendix J). SARs were held constant in all simulations.

Preliminary Results

Wenatchee spring Chinook

- Preliminary results of AHA analysis suggest that the hatchery environment may have a large effect on the fitness of naturally produced Chinook.

[136] Hydropower effects in the AHA model are captured in SARs, which include factors in addition to just hydropower effects (see Section 3.9).

- A higher level of integration may be possible under the present condition scenario by reducing the number of hatchery produced Chinook on the spawning grounds through removal at collection points or selective harvest.
- Scenario 3 habitat improvements may lead to a larger number of naturally produced returns. Additional returns of naturally produced fish may be realized if habitat improvements are coupled with removal of some hatchery produced Chinook.
- Scenario 1 habitat improvements may not have a large effect on the integration rate unless the number of hatchery produced Chinook are further reduced on spawning grounds.

Wenatchee steelhead

- Preliminary results of AHA analysis suggest that the hatchery environment may have a large effect on the fitness of naturally produced steelhead.
- A higher level of integration may be possible by reducing the number of hatchery produced steelhead on the spawning grounds through either removal at collection points or selective harvest.
- Scenario 1 habitat improvements (and their effect on the number of naturally produced fish) will probably increase returns of naturally produced fish.
- Scenario 3 habitat improvements may lead to a larger number of naturally produced returns. Additional returns could be realized if habitat improvements are combined with removal of some hatchery-produced steelhead.

Entiat spring Chinook

No AHA analysis was run on Entiat spring Chinook. This work will be conducted by the local watershed group and USFWS.

Entiat steelhead

No AHA analysis was run on Entiat steelhead. This work will be conducted by the local watershed group.

Methow spring Chinook

- Preliminary results of AHA analysis suggest that the hatchery environment may have a large effect on the fitness of naturally produced Chinook.
- A higher level of integration may be possible by reducing the number of hatchery produced Chinook on the spawning grounds through either removal at collection points or selective harvest.
- Scenario 3 habitat improvements may lead to a larger number of naturally produced returns. Additional returns could be realized if habitat improvements are combined with removal of some hatchery produced Chinook.
- Scenario 1 habitat improvements will probably increase returns of naturally produced Chinook to spawning grounds.

Methow steelhead

- Preliminary results of AHA analysis suggest that the hatchery environment may have a large effect on the fitness of naturally produced steelhead.
- A higher level of integration may be possible by reducing the number of hatchery produced steelhead on the spawning grounds through either removal at collection points or selective harvest.
- Scenario 3 habitat improvements may lead to a larger number of naturally produced returns. Additional returns could be realized if habitat improvements are combined with removal of some hatchery-produced steelhead.
- Scenario 1 habitat improvements may increase returns of naturally produced steelhead to spawning grounds.

Okanogan steelhead

- Poor productivity of the natural environment currently prevents many naturally produced steelhead from being present in the Okanogan subbasin.
- Preliminary results of AHA analysis revealed that the hatchery environment may have a large effect on the fitness of naturally produced steelhead. Potential habitat improvements should increased survival for both naturally and hatchery produced returns and thus supports the transition to an integrated program.
- Under present conditions, additional naturally produced steelhead are incorporated as broodstock, which improves integration rate. A higher level of integration may be possible by reducing the number of hatchery produced steelhead on the spawning grounds through either removal at collection points or selective harvest.
- Scenario 3 habitat improvements may lead to a larger number of naturally produced returns. Additional returns could be realized if habitat improvements are combined with removal of some hatchery-produced steelhead.
- Scenario 1 habitat improvements may allow for 100% use of naturally produced steelhead for hatchery broodstock and increase returns of naturally produced steelhead.

5.6.3 Conclusion

Both approaches suggest that the recovery actions recommended in this plan should significantly improve the survival of naturally produced spring Chinook and steelhead in the Upper Columbia Basin. In addition, recommended actions within the habitat sector should improve the spatial structure and habitat quality within major spawning areas, allowing the populations to meet spatial structure requirements. Implementing actions recommended within the hatchery sector should remove the threats associated with diversity and likely lead to a diversity status that would meet the requirements of a VSP.

It is important to note that the integration analysis did not consider potential improvements in the estuary that may improve the survival of Upper Columbia populations. Actions that reduce toxics and predation in the estuary may translate into a relatively large survival benefit for Upper

Columbia populations. These issues notwithstanding, it is highly probable that the combined actions within all sectors, including actions within the lower Columbia River and estuary, will move Upper Columbia populations to a more viable state. The monitoring and adaptive management program outlined in Section 8 will be used to demonstrate progress toward recovery of Upper Columbia ESU and DPS.

Table 5.1 Naturally produced Upper Columbia Steelhead run-size criteria and mortality take-limit for recreational harvest fisheries in the Wenatchee River, Methow River, and Okanogan Basin spawning areas. Catch-and-release mortality is assumed to be 5%. From NMFS (2003).

Tier	Priest Rapids count	Estimated escapement to tributary area	Mortality impact (%)
Wenatchee River and Columbia River between Rock Island and Rocky Reach dams			
	<837	<599	0
Tier 1	838	600	2
Tier 2	2,146	1,700	4
Tier 3	3,098	2,500	6
Methow River and Columbia River upstream from Wells Dam			
	<908	<499	0
Tier 1	804	500	2
Tier 2	2,224	1,600	4
Tier 3	3,386	2,500	6
Okanogan Basin upstream of Highway 97 Bridge			
	<175	<119	0
Tier 1	176	120	5
Tier 2	180	120	7
Tier 3	795	600	10

Table 5.2 Artificial propagation programs in the Upper Columbia Basin in 2005 listed by release basin, primary hatchery facility association, program operators, and funding source

Program	Primary Facility	Operator(s)	Funding Source(s)
Wenatchee River Basin Releases			
Chiwawa spring Chinook	Eastbank Hatchery	WDFW	CPUD
White River spring Chinook	WDFW, USFWS, and private	WDFW	GPUD
Carson spring Chinook	Leavenworth NFH	USFWS	BOR
Wenatchee coho	USFWS facilities	YN/USFWS	BPA
Wenatchee sockeye	Eastbank Hatchery	WDFW	CPUD
Wenatchee steelhead	Eastbank Hatchery	WDFW	CPUD
Wenatchee summer Chinook	Eastbank Hatchery	WDFW	CPUD
Entiat River Basin Releases			
Carson spring Chinook	Entiat NFH	USFWS	BOR
Methow River Basin Releases			
Chewuch spring Chinook	Methow Hatchery	WDFW	DPUD/CPUD/GPUD
Methow Composite spring Chinook	Methow Hatchery	WDFW	DPUD/CPUD/GPUD
Methow summer Chinook	Eastbank Hatchery	WDFW	CPUD
Methow/Okanogan coho	USFWS facilities	YN/USFWS	BPA
Twisp spring Chinook	Methow Hatchery	WDFW	DPUD/CPUD/GPUD
Wells steelhead	Wells Hatchery	WDFW	DPUD
Methow Composite spring Chinook	Winthrop NFH	USFWS	BOR
Methow summer Chinook steelhead	Winthrop NFH	USFWS	BOR
Okanogan River Basin Releases			
Colville Tribes Okanogan steelhead	Colville Tribes Hatchery	Colville Tribes	BPA
Carson spring Chinook	Leavenworth Complex	USFWS	BOR
Okanogan summer Chinook	Eastbank Hatchery	WDFW	CPUD
Wells steelhead	Wells Hatchery	WDFW	DPUD
Columbia River Releases			
Turtle Rock summer Chinook subyearlings	Eastbank Hatchery	WDFW	CPUD
Turtle Rock summer Chinook yearlings	Eastbank Hatchery	WDFW	CPUD
Wells summer Chinook subyearlings	Wells Hatchery	WDFW	DPUD
Wells summer Chinook yearlings	Wells Hatchery	WDFW	DPUD

Table 5.3 Summary of artificial anadromous fish production in the Wenatchee subbasin

Fish Species	Facility	Funding Source	ESA Listed	Current production level goals
Spring Chinook	Eastbank Fish Hatchery Complex (Chiwawa acclimation pond) (Operated by WDFW)	Chelan County PUD	Yes	672,000 (will decrease in future)
	Leavenworth National Fish Hatchery (Operated by USFWS)	Bureau of Reclamation	No	1,625,000
	Captive brood program in Manchester and Willard (Operated by Aquaseed; may expand to facility in White River Basin; and USFWS)	Grant PUD	Yes	200,000 [This obligation may be partially met by other means in the future, current production much lower (< 50,000)]
	TBD – Nason Cr. release	Grant PUD	Yes	up to 400,000 (future production)
Steelhead	Eastbank Fish Hatchery Complex (Operated by WDFW)	Chelan PUD	Yes	400,000 (will decrease in future)
Summer Chinook	Eastbank Fish Hatchery Complex (Dryden acclimation pond) (Operated by WDFW)	Chelan PUD	No	864,000 (will decrease in future)
Sockeye	Eastbank Hatchery (Lake Wenatchee net pens; Operated by WDFW)	Chelan PUD	No	200,000 (will increase up to 280,000 in future)
Coho	Leavenworth NFH (Operated by USFWS for YN)	BPA (Fish & Wildlife Program)	No	> 500,000
	Acclimation sites at Nason Creek and Icicle Creek (YN)	BPA (Fish & Wildlife Program)	No	< 500,000

Table 5.4 Summary of artificial anadromous fish production in the Entiat subbasin

Fish Species	Facility	Funding Source	ESA Listed	Production level goals
Spring Chinook	Entiat NFH (Operated by USFWS)	Bureau of Reclamation	No	400,000

Table 5.5 Summary of artificial anadromous fish production in the Methow subbasin

Fish Species	Facility	Funding Source	ESA Listed	Production level goals
Spring Chinook	Methow Fish Hatchery Acclimation sites at the Methow, Biddle, Twisp, and Chewuch Acclimation ponds (Operated by WDFW)	Douglas PUD, Chelan PUD, and Grant PUD	Yes	550,000[137]
	Winthrop NFH (Operated by USFWS)	Bureau of Reclamation	Yes	600,000
Steelhead	Wells Dam Hatchery Complex (Operated by WDFW)	Douglas County PUD and Grant County PUD	Yes	349,000[138]
	Winthrop NFH (Operated by USFWS)	Bureau of Reclamation	Yes	100,000
Summer Chinook	Wells Dam Hatchery Complex (Carlton acclimation pond) (Operated by WDFW)	Chelan County PUD, Douglas County PUD	No	400,000[139]
Coho	Winthrop NFH (Operated by USFWS for YN)	BPA (Fish & Wildlife Program)	No	250,000

[137] Currently, 61,000 of these spring Chinook are for DPUD mitigation, 288,000 for CPUD, and 201,000 are for GPUD. In the future, the CPUD and GPUD proportion will most likely change, but the total may not, although it could be increased to over 700,000 with facility modifications.
[138] 100,000 of these fish are for GPUD.
[139] 109,000 of these fish are for DPUD mitigation and the rest are for CPUD mitigation. In the future (no later than 2013), CPUD mitigation numbers may be reduced.

Table 5.6 Broodstock collection guidelines of the Methow Basin spring Chinook supplementation plan (ESA Section 7 Draft Biological Opinion, Section 10 Permit 1196)

Wells Escapement Projection	Broodstock Collection Objective
<668	WDFW may collect 100% of Wells Dam escapement; place all fish into the adult-based supplementation program.
>668 but <964	Pass a minimum of 296 adults upstream of Wells Dam for natural spawning.
>964	Collection at levels to meet interim production level of 550,000 and 600,000 smolts at Methow Fish Hatchery and Winthrop NFH, respectively.

Table 5.7 Current artificial anadromous fish production in the Okanogan subbasin

Fish Species	Facility	Funding Source	ESA Listed	Production level goals
Spring Chinook	Omak Creek, Ellisford Pond (operated by Colville Tribes (CCT))	BPA, CCT	No	30,000-150,000 (current production is dependent on availability of Carson-stock eggs)
Steelhead	Wells hatchery, Omak Cr. (operated by CCT)	DPUD	Yes	100,000
Summer Chinook	Similkameen rearing pond (operated by WDFW)	Chelan PUD	No	576,000 (will decrease in future)
Sockeye	none	Douglas PUD	No	To compensate for loss of smolts for the operation of Wells Dam, DPUD has funded a cooperative water flow effort in the Okanogan River upstream from Lake Osoyoos, which has increased survival of incubating and downstream migration to the lake of sockeye.
	Varied, in Canada (operated by ONA, DFO)	Grant PUD, (CPUD – future), Okanogan Nations Alliance	No	The ONA are currently attempting to reintroduce sockeye fry into Skaha Lake on a 12-year experimental basis.

Table 5.8 Numbers of different habitat activities implemented within the Upper Columbia Basin within the last 10 years

Activity	Project location				
	Wenatchee	**Entiat**	**Methow**	**Okanogan**	**Mainstem & small tribs**
Acquisition	10	3	9	4	0
Assessment	14	10	13	13	16
Passage	7	9	11	1	3
Habitat improvement	13	35	46	14	2
Planning	7	4	4	0	3
RME	16	6	7	5	6
Screening	5	0	19	0	0
Water quality	2	2	3	2	1
Water quantity	1	0	33	3	0
Total	**75**	**69**	**145**	**42**	**31**

Table 5.9 Habitat action classes and a listing of potential actions associated with each action class. Note that the list of potential actions is not all-inclusive. The list is intended as a guide for local habitat groups in selecting potential actions. Additional potential actions not identified in the list may be appropriate provided they address the action class. None of the actions identified in this table are intended to, nor shall they in any way, abridge, limit, diminish, abrogate, adjudicate, or resolve any authority or Indian right protected by statute, executive order, or treaty. This language shall be deemed to modify each and every section of this recovery plan as if it were set out separately in each section.

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
Riparian Restoration	Actions in this class generally apply to the **productivity** and **abundance** VSP parameters and address limiting and causal factors such as loss of bank stability, impacts from agriculture and livestock, increased sediment input above natural levels, elevated temperatures, depressed invertebrate production, and loss of natural LWD recruitment.	1. Plant trees and shrubs to provide shade, especially those in close proximity to streams, stream banks, and gravel/boulder bars. 2. Restore riparian buffers using incentive mechanisms provided in shoreline master programs and farm conservation plans and programs to avoid or minimize removal of native vegetation. 3. Replace invasive or non-native vegetation with native vegetation. 4. Maintain or improve fencing or fish friendly stream crossing structures to prevent livestock access to riparian zones and streams. 5. Provide alternative sites for stock watering. 6. Maintain or decommission roads and trails in riparian areas. 7. Connect off-channel habitats to improve floodplain and wetlands processes and functions. 8. Replant degraded riparian zones by reestablishing native vegetation. 9. Selectively thin, remove, and prune non-native and invasive vegetation. 10. Improve riparian conditions by increasing filtration capacity through vegetation planting, CREP enrollment, selected livestock fencing, and similar practices, including intermittent streams that contribute to priority areas. 11. Implement the most economical and effective treatment methods to control noxious weeds, including the encouragement of biological control methods where feasible and appropriate. 12. Establish stream flow requirements (within the natural hydrologic regime and existing water rights) using empirical data to protect and maintain riparian habitat. 13. Apply best management practices (BMPs) to agricultural and grazing

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
		practices where they are proven to restore functional riparian condition. 14. Recreation management.
Side-Channel Reconnection	Actions in this class generally apply to the **productivity** and **abundance** VSP parameters and address limiting and causal factors such as loss of channel sinuosity and length, decreased habitat refugia and diversity, loss of hyporheic function associated with floodplains, increased bed scour by concentrating river energy, loss of bank stability, losses of habitat quantity and quality from agriculture and livestock activities, increased sediment input above natural levels, elevated temperature, depressed invertebrate production, and loss of natural LWD recruitment.	1. Restore and/or reconnect side-channel habitats, islands, spawning channels, and reconnect back channels to increase LWD deposition, channel complexity, and riparian areas. 2. Re-slope vertical banks and establish wetland habitats by connecting the floodplain with the channel. 3. Identify, protect, and re-establish ground-water sources. 4. Provide stream flows that water side channels and off-channel habitats.
Obstruction Restoration	Actions in this class generally apply to the **diversity, structure,** and **abundance** VSP parameters. Removing barriers addresses limiting and causal factors such as loss of habitat quantity, habitat fragmentation, decreased habitat refugia and diversity, and increased density-dependent mortality from concentrating populations into small habitat units.	1. Design and construct road culverts and screens consistent with the newest standards and guidelines. 2. Remove, modify, or replace dams, culverts, and diversions that prevent or restrict access to salmon or trout habitat and/or cause loss of habitat connectivity. 3. Address fish passage and screening concerns, as much as possible, in other restoration and protection efforts. Effectively operate and maintain culverts and other instream structures. 4. Develop tributary channels as bypass habitat around dams. 5. Convert to low-head, run-of-the-river projects. 6. Establish and provide fish passage flows (eliminate low flow barriers). 7. Reduce flow fluctuations (associated with power generation, flood control, etc.) to allow passage through shallow-water habitats.
Water Quality Restoration	Actions in this class generally apply to VSP parameters of **productivity** and **abundance**, and to a lesser degree, **diversity**. Water quality includes factors and pollutants such as chemicals, metals, temperature, Biological Oxygen Demand (BOD), and nutrients. Predation by exotic species can be decreased with improved water quality and benthic	1. Reduce Biological Oxygen Demand (BOD) by reducing nutrient inflow into lakes and streams. 2. Re-establish groundwater sources. 3. Implement existing water-quality plans.

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
	macroinvertebrate community structure can be recovered to natural levels, improving survival and growth of salmonids.	4. Clean-up mine tailings. 5. Remove and properly dispose of arsenic contaminated sediments. 6. Use State Environmental Policy Act (SEPA) to prevent, minimize, or mitigate both immediate and long-term impacts. 7. Establish and protect riparian buffers. 8. Assess the value of vegetation removal. 9. Implement Total Maximum Daily Loads (TMDLs) that address temperature (as a pollutant). 10. Use incentives and technical assistance, such as Conservation Reserve Enhancement Program (CREP). 11. Implement education programs. 12. Implement best management farm practices. 13. Implement nonpoint source control techniques for urban areas. 14. Manage development, road construction, logging, and intensive farming in areas with high likelihood of occurrence of mass wasting (unstable slopes) and/or erosion. 15. Restore geomorphic features such as connectivity with floodplain gravels, pool-riffle sequences, meander bends, backwaters, and side channels. 16. Improve the extent, structure, and function of riparian buffers to increase their filtration capacity through increasing the density, maturity, and appropriate species composition of woody vegetation, understory vegetation planting, CREP enrollment, selected livestock fencing, and similar practices. 17. Identify jurisdictions with inadequate land use regulations and work to strengthen existing or pass new regulations that better protect the structure and function of riparian areas and wetlands. 18. Protect riparian vegetation to improve water quality through promotion of livestock BMPs such as alternative grazing rotations and the installation of alternative forms of water for livestock 19. Restore perennial vegetation in upland cultivated and non-cultivated areas with native species and reforestation.

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
		20. Minimize surface water withdrawals (increases stream flow) through implementation of irrigation efficiencies, quantify legal withdrawals, identify and eliminate illegal withdrawals, lease of water rights and purchase of water rights that would not impact agriculture production. 21. Improve upland water infiltration through road decommissioning, reduced soil compaction, direct seeding activities, increasing native vegetation cover, and CRP participation. 22. Continue development and implementation of TMDLs and other watershed scale efforts to remedy local factors negatively influencing temperature regimes. 23. Conduct appropriate shade restoration activities where streamside shading has been reduced by anthropogenic activities (temperature attenuation). 24. Protect wetland and riparian habitats. 25. Enhance the extent and function of wetlands and wet meadows. 26. Manage sources of high-temperature inputs to surface waters. 27. Implement upland BMPs, including activities such as sediment basins on intermittent streams. 28. Monitor hatchery and other NPDES (point sources) for effluent, nutrients, contaminants, and pathogens and correct as needed. 29. Construct detention and infiltration ponds to capture runoff from roads, development, farms, and irrigation return flows. 30. Reduce hazardous fuels and materials.
Water Quantity Restoration	Actions in this class generally apply to the **productivity**, **abundance**, **diversity** and **structure** VSP parameters. Restoration actions will address limiting and causal factors such as blocked and/or impeded fish passage, loss of habitat quantity and quality, increased temperature, and benthic macroinvertebrate production.	1. Buy or lease water rights that would not impact agriculture production, implement water conservation, reconnect river channels. 2. Develop and enforce minimum in-stream flows for aquatic resources within the natural hydrologic regime and existing water rights. 3. Develop programs that assist water users and promote the efficient use of water. 4. Implement activities that promote water storage and groundwater recharge that collectively add to existing in-stream flows.

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
		5. Put or keep water in the streams using innovative tools, such as water banking; lease or purchase senior water rights; trust water donation; water conservation and reuse; and water storage and groundwater recharge that are within the natural hydrologic regime and existing water rights. 6. Manage stormwater and reduce the extent of impervious surfaces. 7. Regulate reservoir pool levels to improve salmonid migration rates and minimize competitor and predator effects. 8. Use drawdown to create flow and turbidity conditions conducive to salmonid migration. 9. Restore perennial vegetation in upland cultivated and non-cultivated areas with native species and reforestation. 10. Educate the public on existing land use and instream work regulations (e.g., critical area ordinances, HPA requirements, DSL requirements, etc.) that limit riparian area development. 11. Improve watershed function by increasing upland water infiltration, road decommissioning, reducing soil compaction, seeding activities, increasing native vegetation cover, and CRP participation. 12. Investigate feasibility of water storage in coordination with federal, tribal, state, and local governments and stakeholders. 13. Implement shallow aquifer recharge programs. 14. Encourage beaver re-population. 15. Protect and restore springs, seeps, and wetlands that function as water storage during spring flows and provide recharge during summer drought periods. 16. Minimize surface water withdrawals through implementation of irrigation efficiencies, quantify legal withdrawals, identify and eliminate illegal withdrawals, lease of water rights, and purchase of water rights that do not impact agriculture production, with the exception of illegal withdrawals. 17. Pursue opportunities to convert surface water uses to well supplies and explore feasibility of changing surface water point of diversion from tributaries to the Columbia River.

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
		18. Improve municipal stormwater management to minimize peak flow levels. 19. Pursue use of constructed wetlands in appropriate areas for peak flow management, infiltration, and stormwater retention.
Instream Structures	Actions in this class generally apply to the **productivity** and **abundance** VSP parameters. These actions address limiting factors and causal factors such as loss of natural stream channel complexity, refugia and hiding cover, sinuosity, stream length, loss of floodplain connectivity, unnatural width to depth ratios, embeddedness, unstable banks, increased fine sediment, loss of pool and riffle formation, and spawning gravel and natural LWD recruitment.	1. Install instream structures such as boulders and rock weirs to increase short-term pool formation and long-term habitat diversity. 2. Add rock weirs or boulders to increase channel roughness. 3. Install habitat boulders. 4. Install instream structures to slow water velocities and increase gravel retention. 5. Install any other form of instream structure that has been deemed beneficial through literature review or project demonstration.
Road Maintenance	Actions in this class generally apply to the **productivity** and **abundance** VSP parameters. Actions in this class address limiting factors and causal factors such as loss of natural stream channel complexity, sinuosity, stream length, loss of floodplain connectivity, unnatural width to depth ratios, embeddedness, unstable banks, increased sediment, loss of pool and riffle formation, and spawning gravel and LWD recruitment.	1. New development will be consistent with shoreline management guidelines, local Critical Area Ordinances, hydraulic project approval, and other state and/or local regulations or permits. 2. Establish and protect riparian buffers using incentive mechanisms provided in Critical Area Ordinances, shoreline master programs, forest practices regulations, farm conservation plans and other programs to avoid or minimize channel constriction, input of chemicals and exacerbate or create modified runoff or stormwater flow. 3. Implement road maintenance and abandonment or decommissioning plans. 4. Manage the placement of dikes and other structures that may confine or restrict side channels and disconnect habitat in floodplains. 5. Decrease sediment delivery through expanded use of sediment basins, eliminating side-casting, CRP participation, mowing of road shoulders in place of herbicide use, and/or vegetative buffers on road shoulders. 6. Implement best management practices for bridge maintenance activities to eliminate build-up of sediment and other materials. 7. Improve watershed conditions (e.g., upland water infiltration) through road decommissioning, reduced soil compaction, direct seeding activities,

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
		increasing native vegetation cover, and/or CRP participation. 8. Decommission, modify, or relocate (i.e., setback) roads, bridges, and culverts to decrease stream confinement to the extent practicable. 9. Manage road runoff and retrofit projects to address stormwater runoff concerns. 10. Pave, decommission, or relocate roads away from streams. 11. Remove, reconstruct, or upgrade roads that are vulnerable to failure due to design or location. 12. Minimize total road density within the watershed and provide adequate drainage control for new roads. 13. Avoid road construction and soil disturbance in proximity to riparian areas, wetlands, unstable slopes, and areas where sediment related degradation has been identified. 14. Maintain drainage ditches, culverts, and other drainage structures to prevent clogging with debris and sediments.
Floodplain Restoration	Actions in this class generally apply to the **productivity**, **abundance**, **diversity**, and **structure** VSP parameters. These actions address limiting factors and causal factors such as channel incision, increased temperature, poor water quality, loss of natural stream channel and habitat complexity, sinuosity, stream length, unnatural width to depth ratios, embeddedness, unstable banks, increased fine sediments, loss of pool and riffle formation, and spawning gravel and LWD recruitment.	1. Create diverse channel patterns to enhance water circulation through floodplain gravels. 2. Use dike setbacks, removal, breaching, sloping, and/or channel reconnection to connect the channel with the floodplain. 3. Increase flood-prone areas to reduce lateral scour and flow volume in main channel and protect or improve existing spawning habitats. 4. Restore and reconnect wetlands and floodplains to the riverine system where appropriate. 5. Reconnect floodplain (off-channel) habitats where appropriate. 6. Decommission or relocate roads, low-priority dikes, bridges, and culverts to enhance floodplain connectivity. 7. Use setback levees and flood walls to recharge floodplain habitats.
Large Woody Debris	Actions in this class generally apply to the **productivity** and **abundance** VSP parameters. These actions address limiting factors and causal factors such as loss of natural stream	1. Add key pieces of wood to stabilize banks, provide hiding cover, and reestablish natural channel geomorphology (pool:riffle, width:depth,

Habitat Action Class	Relationship to VSP and Limiting Factors	List of Potential Habitat Actions
Restoration	channel complexity, refugia and hiding cover, sinuosity, stream length, loss of floodplain connectivity, unnatural width to depth ratios, embeddedness, unstable banks, increased fine sediments, loss of pool and riffle formation, and spawning gravel and natural LWD recruitment.	sediment transport, etc.). 2. Improve riparian habitats by planting native vegetation with the potential to contribute to future LWD recruitment. 3. Create side-channel habitats, islands, and reconnect back channels to increase LWD deposition, channel complexity, and riparian areas to reestablish normative processes, such that short-term fixes (placement) are only used in the interim. 4. Add rootwads, log jams, and similar structures that mimic natural formations. 5. Increase the density, maturity, and appropriate species composition of woody vegetation in riparian buffers for long-term recruitment of LWD. 6. Improve natural stream form and function (e.g., meander reconstruction in Rosgen C channels) to facilitate LWD retention. 7. Encourage beaver re-population. 8. Install LWD for short-term pool formation. 9. Add large woody debris and place in-channel engineered log jams.
Nutrient Restoration	Actions in this class generally apply to **abundance** and **productivity** VSP parameters. Nutrients, from sources such as salmon carcasses, provide food for juvenile salmon, nutrients for riparian plants and benthic macroinvertebrates. Additionally, salmon carcasses provide forage for wildlife.	1. Add hatchery salmon carcasses to stream. 2. Add nutrient analogs to streams.

Table 5.10 Rating of assessment units within each subbasin according to their potential for recovery of listed species in the Upper Columbia Basin. Ratings are from the Biological Strategy (UCRTT 2003) and range from Category 1 (highest) to Category 4 (lowest). Category 1 and 2 assessment units include areas that should be protected (see text)

Subbasin	Assessment Unit	Action Category
Wenatchee	Lower Wenatchee River	Category 2
	Mission Creek	Category 3
	Peshastin Creek	Category 2
	Chumstick Creek	Category 3
	Lower Icicle (mouth to boulder field)	Category 2
	Upper Icicle (upstream from boulder field)	Category 2
	Middle Wenatchee (Tumwater Canyon)	Category 1
	Upper Wenatchee (upstream of Tumwater)	Category 1
	Chiwaukum (includes Skinney Creek)	Category 2
	Chiwawa River	Category 1
	Nason Creek	Category 2
	Lake Wenatchee	Category 1
	Little Wenatchee River	Category 1
	White River	Category 1
Entiat	Lower Entiat River	Category 2
	Middle Entiat River	Category 1
	Upper Entiat River	Category 1
	Mad River	Category 1
Methow	Lower Methow River	Category 2
	Middle Methow River	Category 2
	Upper-Middle Methow River	Category 2
	Upper Methow/Early Winters/Lost	Category 1
	Black Canyon/Squaw Creek	Category 3
	Gold/Libby Creek	Category 3
	Beaver/Bear Creek	Category 3
	Lower Twisp	Category 2
	Upper Twisp	Category 1
	Lower Chewuch	Category 2
	Upper Chewuch	Category 1
	Wolf/Hancock Creek	Category 2

Subbasin	Assessment Unit	Action Category
	Goat/Little Boulder Creek	Category 3
Okanogan	Lower Okanogan	Category 2
	Middle Okanogan	Category 2
	Upper Okanogan	Category 2
	Loup Loup Creek	Category 4
	Lower Salmon Creek	Category 3
	Upper Salmon and Tributaries	Category 3
	Omak and Tributaries	Category 2
	Small Tributary Systems	Category 4
	Similkameen River	Category 3
	Osoyoos Lake	Category 3

Table 5.11 Summary of possible increases in survival from recommended actions identified in this plan. The numbers in red indicate minimum estimates for Entiat steelhead, because there are no productivity estimates from recommended habitat actions (see Appendix I).

Sector	Area	Spring Chinook Productivity					Steelhead Productivity[1]				
		Current (C)	Low Potential (P)	High Potential (P)	Low P/C	High P/C	Current (C)	Low Potential (P)	High Potential (P)	Low P/C	High P/C
Harvest	Wenatchee	0.74	0.74	0.75	1.00	1.01	0.69	0.69	0.70	1.00	1.01
	Entiat	0.76	0.76	0.77	1.00	1.01	0.69	0.69	0.70	1.00	1.01
	Methow	0.51	0.51	0.52	1.00	1.01	0.91	0.91	0.92	1.00	1.01
	Okanogan	---	---	---	---	---	0.91	0.91	0.92	1.00	1.01
Hatchery	Wenatchee	0.74	0.76	0.78	1.03	1.05	0.69	0.71	0.72	1.03	1.05
	Entiat	0.76	0.78	0.80	1.03	1.05	0.69	0.71	0.72	1.03	1.05
	Methow	0.51	0.54	0.56	1.05	1.10	0.91	0.96	1.00	1.05	1.10
	Okanogan	---	---	---	---	---	0.91	0.96	1.00	1.05	1.10
Hydro[2]	Wenatchee	0.74	1.09	1.09	1.47	1.47	0.69	0.97	0.97	1.40	1.40
	Entiat	0.76	1.20	1.20	1.58	1.58	0.69	1.03	1.03	1.49	1.49
	Methow	0.51	0.84	0.84	1.65	1.65	0.91	1.36	1.36	1.49	1.49
	Okanogan	---	---	---	---	---	0.91	1.36	1.36	1.49	1.49
Habitat (33%-100%)[3]	Wenatchee	0.74	0.93	1.00	1.25	1.35	0.69	0.87	0.90	1.26	1.31
	Entiat[4]	0.76	0.78	0.78	1.03	1.03	0.69	---	---	---	---
	Methow	0.51	0.58	0.69	1.14	1.36	0.91	1.04	1.24	1.14	1.36
	Okanogan	---	---	---	---	---	0.91	1.34	1.49	1.47	1.64
Integration across all sectors	Wenatchee	0.74	1.40	1.56	1.89	2.10	0.69	1.25	1.34	1.82	1.94
	Entiat	0.76	1.27	1.31	1.67	1.72	0.69	1.06	1.09	1.53	1.58
	Methow	0.51	1.01	1.27	1.98	2.49	0.91	1.62	2.05	1.78	2.25
	Okanogan	---	---	---	---	---	0.91	2.10	2.47	2.30	2.71

[1] Productivity was based on a hatchery effectiveness of H = 0.5.

[2] The survival estimates provided here were based on the draft Quantitative Analysis Report (QAR). They include survival gains associated with long-term benefits in the FCRPS.

[3] EDT modeled two habitat improvement scenarios for the Wenatchee, Methow, and Okanogan populations: (1) 33% intensity and (2) 100% intensity (See Appendix F). The 100% intensity may not be feasible to implement because of social/economic factors.

[4] Because the Entiat was not modeled the same as the other subbasins, the total increase in productivity would be greater than shown here (See Appendix F). There was no 100% intensity scenario for the Entiat.

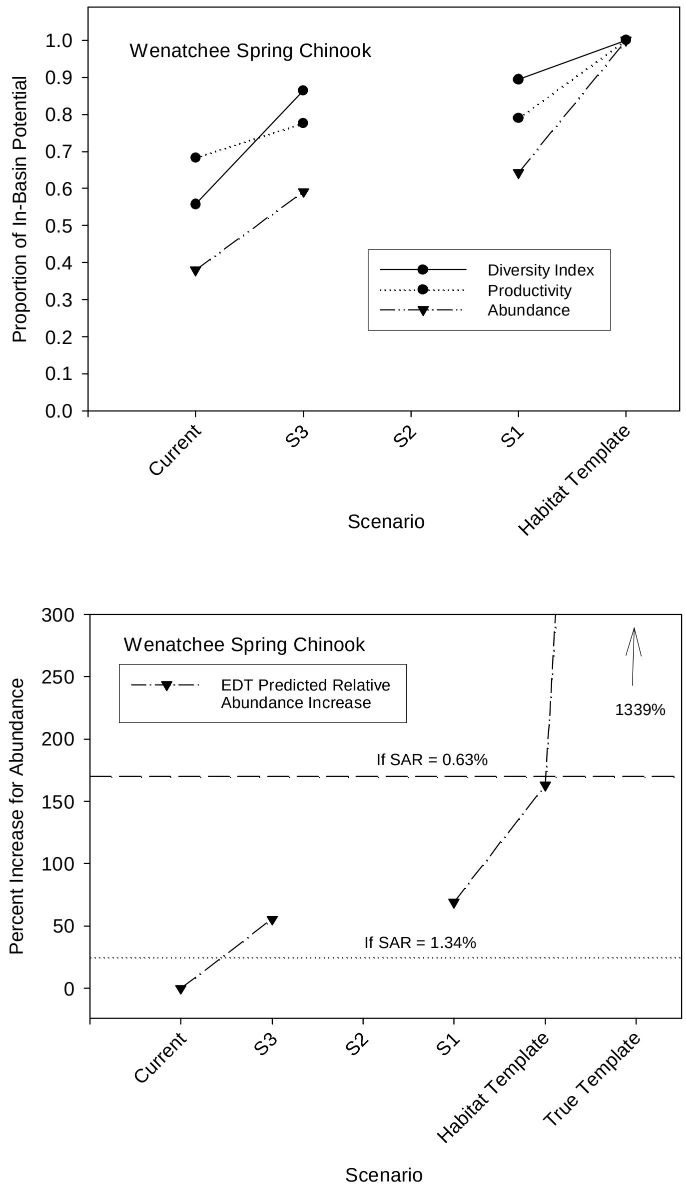


Figure 5.1 ***Top graph*** identifies the proportion of within-subbasin potential for each spring Chinook performance measure realized by each EDT modeling scenario in the Wenatchee subbasin. Scenario 1 (S1) applied the full effectiveness of restoration classes that addressed the primary limiting factors within each assessment unit, regardless of feasibility or cost. Scenario 3 (S3) was 33% the intensity of S1, with full effect of artificial barrier removal and protection. Scenario 2 (S2) is not available at this time. Habitat template indicates the estimated historical condition. ***Bottom graph*** represents the predicted abundance (spawners) based on EDT runs for spring Chinook within the Wenatchee subbasin. The dotted and dashed lines indicate the percent increase needed to reach minimum recovery abundance with SARs of 1.34% (used in EDT model runs) and 0.63% (empirical data from the Chiwawa River). See Appendix F for more details.

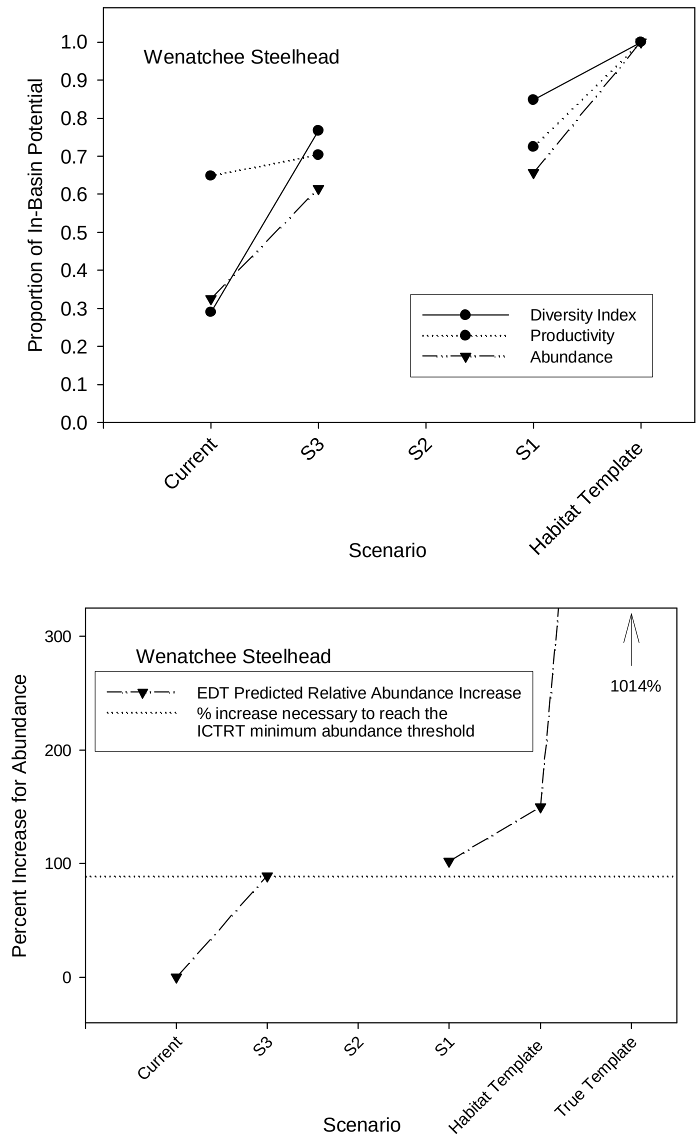
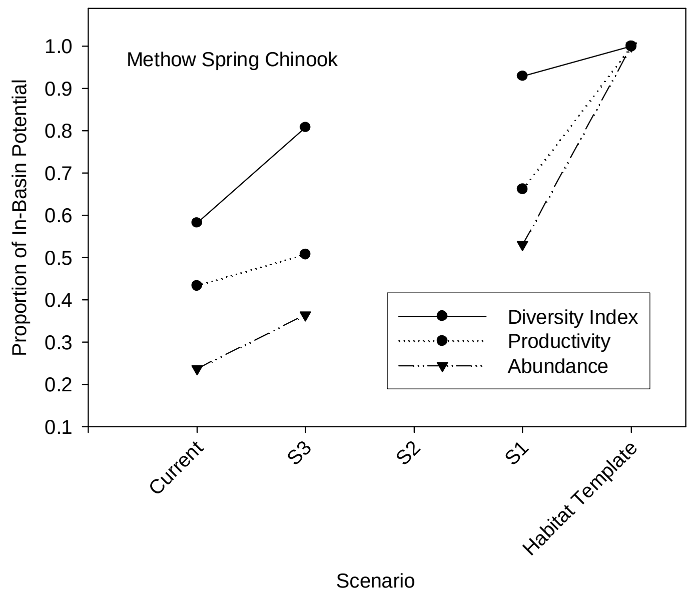


Figure 5.2 ***Top graph*** identifies the proportion of within-subbasin potential for each steelhead performance measure realized by each EDT modeling scenario in the Wenatchee subbasin. Scenario 1 (S1) applied the full effectiveness of restoration classes that addressed the primary limiting factors within each assessment unit, regardless of feasibility or cost. Scenario 3 (S3) was 33% the intensity of S1, with full effect of artificial barrier removal and protection. Scenario 2 (S2) is not available at this time. Habitat template indicates the estimated historical condition. ***Bottom graph*** represents the predicted abundance (spawners) based on EDT runs for steelhead within the Wenatchee subbasin. The model used an average SAR of 1.26%. See Appendix F for more details.



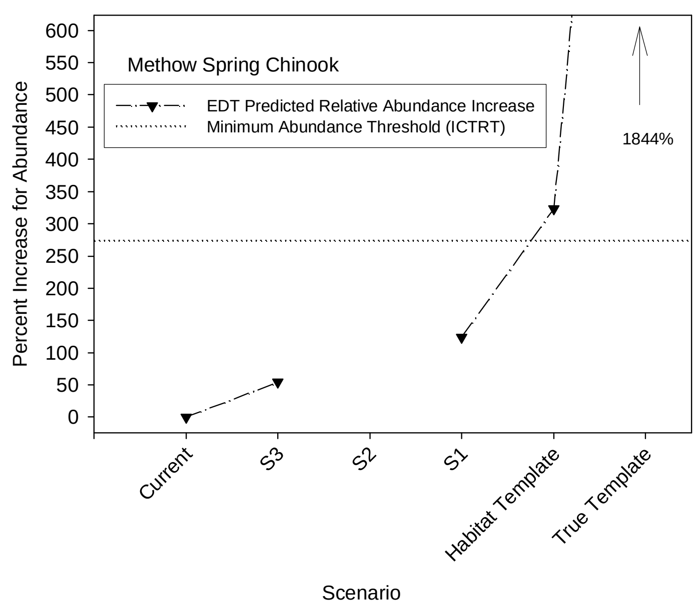
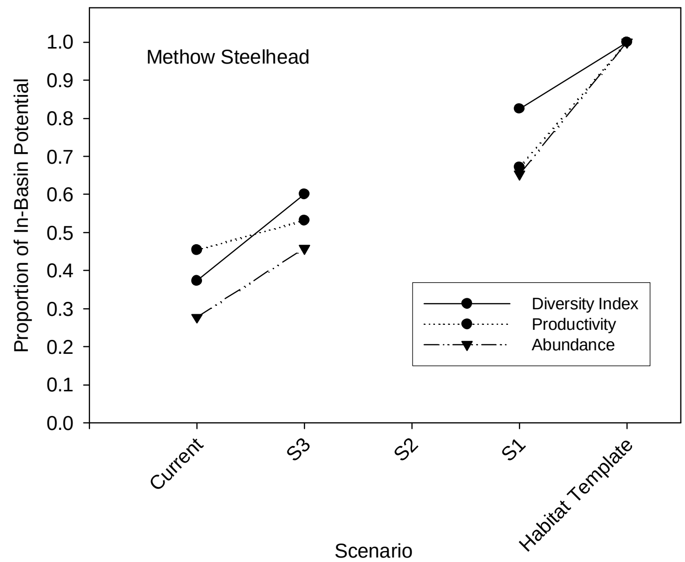


Figure 5.3 ***Top graph*** identifies the proportion of within-subbasin potential for each spring Chinook performance measure realized by each EDT modeling scenario in the Methow subbasin. Scenario 1 (S1) applied the full effectiveness of restoration classes that addressed the primary limiting factors within each assessment unit, regardless of feasibility or cost. Scenario 3 (S3) was 33% the intensity of S1, with full effect of artificial barrier removal and protection. Scenario 2 (S2) is not available at this time. Habitat template indicates the estimated historical condition. ***Bottom graph*** represents the predicted abundance (spawners) based on EDT runs for spring Chinook within the Methow subbasin. The model used an average SAR of 1.24%. See Appendix F for more details.



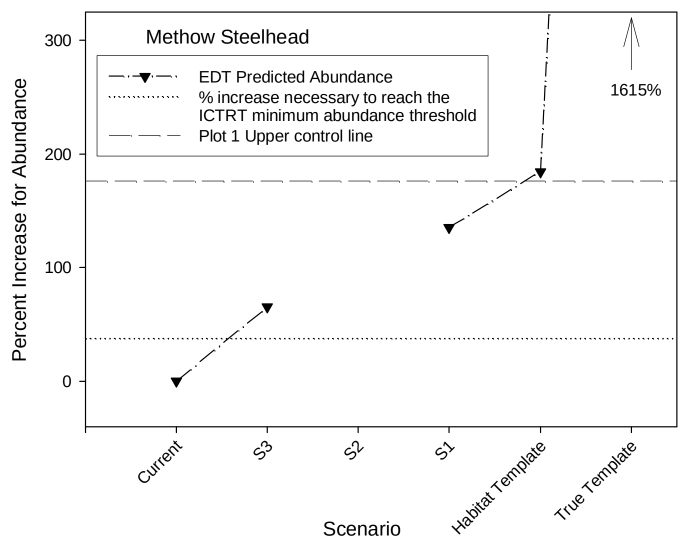
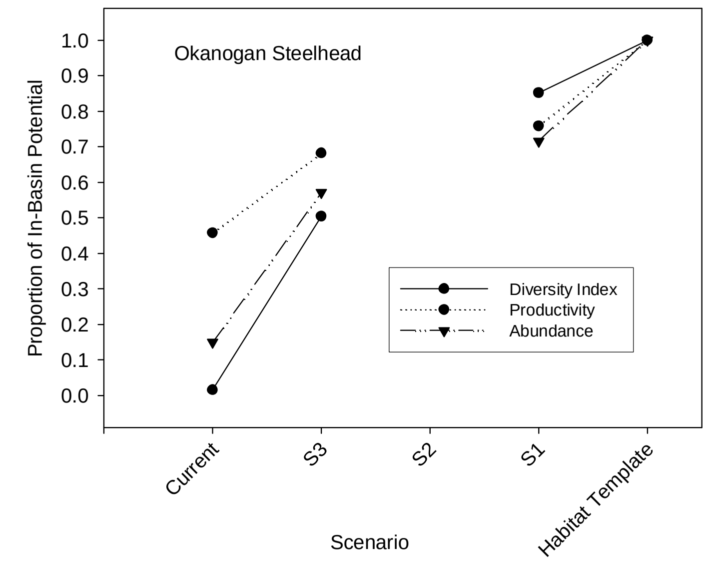


Figure 5.4 ***Top graph*** identifies the proportion of within-subbasin potential for each steelhead performance measure realized by each EDT modeling scenario in the Methow subbasin. Scenario 1 (S1) applied the full effectiveness of restoration classes that addressed the primary limiting factors within each assessment unit, regardless of feasibility or cost. Scenario 3 (S3) was 33% the intensity of S1, with full effect of artificial barrier removal and protection. Scenario 2 (S2) is not available at this time. Habitat template indicates the estimated historical condition. ***Bottom graph*** represents the predicted abundance (spawners) based on EDT runs for steelhead within the Methow subbasin. The model used an average SAR of 1.03%. See Appendix F for more details.



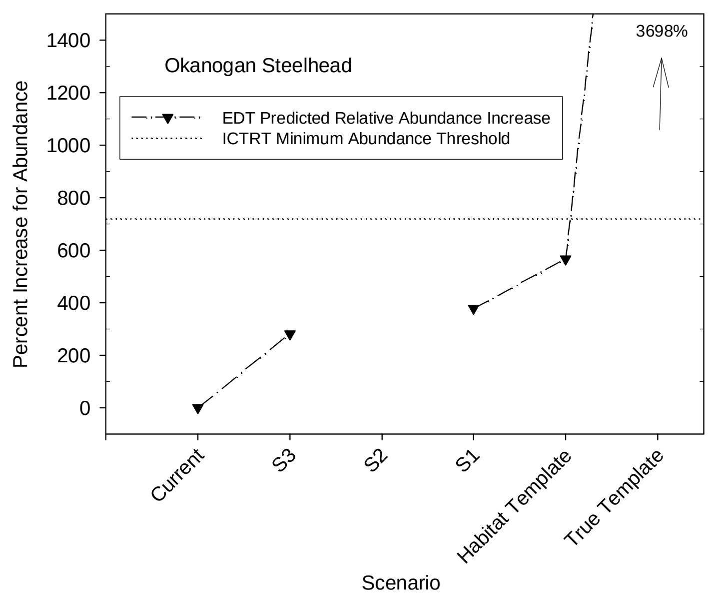


Figure 5.5 ***Top graph*** identifies the proportion of within-subbasin potential for each steelhead performance measure realized by each EDT modeling scenario in the U.S. portion of the Okanogan subbasin. Scenario 1 (S1) applied the full effectiveness of restoration classes that addressed the primary limiting factors within each assessment unit, regardless of feasibility or cost. Scenario 3 (S3) was 33% the intensity of S1, with full effect of artificial barrier removal and protection. Scenario 2 (S2) is not available at this time. Habitat template indicates the estimated historical condition. ***Bottom graph*** represents the predicted abundance (spawners) based on EDT runs for steelhead within the Okanogan subbasin. The model used an average SAR of 0.92%. See Appendix F for more details.

6 Social/Economic Considerations

6.1 Estimated Time and Costs

The ESA section 4(f)(1) requires that the recovery plan include ‘‘estimates of the time required and the cost to carry out those measures needed to achieve the Plan’s goal and to achieve intermediate steps toward that goal’’ (16 U.S.C. 1533[f][1]). At this time it is difficult to estimate the total cost to recover spring Chinook, steelhead, and bull trout in the Upper Columbia River Basin. The USFWS estimates that it will cost about $15 million to recover bull trout in the Upper Columbia Basin (USFWS 2002). This greatly underestimates the total cost of recovering all three listed species. Because of different life-history characteristics of each species, the UCSRB believes that it will cost at least $296 million over a 10-year period to implement habitat actions that will contribute toward recovery of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin (Table 6.1) Also, there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding. The Upper Columbia Plan states that if its recommended actions are implemented, recovery of the spring Chinook salmon ESU and the steelhead DPS is likely to occur within 10 to 30 years. The cost estimates cover work projected to occur within that first decade. This estimate includes expenditures by local, Tribal, state, and Federal governments, private business, and individuals in implementing both capital projects and non-capital work. Before the end of this first implementation period, specific actions and costs will be estimated for subsequent years, to achieve long-term goals and to proceed until a determination is made that listing is no longer necessary.

The $296 million estimate does not include costs associated with hatchery programs because these programs are funded to achieve specific program objectives, which may change based on monitoring and evaluation. The cost estimate also does not include expenses associated with implementing actions within the lower Columbia River, in the estuary, within the FCRPS, or the cost of implementing measures in the PUDs’ Habitat Conservation Plans and Settlement Agreements. Cost estimates for these items are included in two modules that NMFS developed because of the regional scope and applicability of the actions. These modules are incorporated into the Upper Columbia Plan by reference and are available on the NMFS Web site: www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other- Documents.cfm. In addition, the estimate does not include the cost of RM&E.[140]

The hydropower cost estimates will be updated over time, as the section 7 consultation on the remanded 2004 FCRPS BiOp is completed. The estuary recovery costs could be further refined following public comment on the ESA recovery plan for the three listed lower Columbia ESUs and one listed Lower Columbia steelhead DPS in 2007. There are virtually no estimated costs for recovery actions associated with harvest to report at this time. This is because no actions are

[140] RME would include costs of conducting critical uncertainty research in all sectors, monitoring effects of actions within all sectors, monitoring the status and trend of performance measures in all sectors, and monitoring the implementation and compliance of all actions within all sectors.

currently proposed that go beyond those already being implemented through ***U.S. v. Oregon*** and other harvest management forums. In the event that additional harvest actions are implemented through these forums, those costs will be added during the implementation phase of this recovery plan. All cost estimates will be refined and updated over time.

The Upper Columbia Plan estimates it may cost a total of $10 million to cover agency and organization staffing costs during the first 10 years of plan implementation ($1 million/year), and it is conceivable that this level of effort will need to continue for the Plan's duration. Also, continued actions in the management of habitat, hatcheries, and harvest, including both capital and non-capital costs, will likely warrant additional expenditures beyond the first 10 years. Although it is not practicable to accurately estimate the total cost of recovery, it appears that most of the costs will occur in the first 10 years. Annual costs are expected to be lower for the remaining years, thus the total for the entire period (years 11-20) may possibly range from $150 million to $200 million.

6.1.1 Methodology for Cost Estimates

The cost estimates for this recovery plan are similar in methodology for developing the revised cost estimates. The initial project lists sent to EFC identified more than 400 projects on lists compiled by teams in each of the five watersheds that comprise the Upper Columbia salmon recovery region (Methow, Okanogan, Entiat, Mainstem Columbia Tributaries, and Wenatchee). While each list had fields for cost information for each project, allowing the identification of project size, unit costs, and total costs, in the great majority of cases (85-90%) at least one of the key factors was missing, and many projects on each list (35-40%) had no cost information whatsoever.

A taxonomy for Upper Columbia projects was developed and each project was assigned to one of 29 project categories (**Table 6.1**). A small group of projects (30-40) were insufficiently defined to allow categorization and were put in a miscellany category for later analysis. The first substantive analysis occurred by comparing cost estimates within each category. This analysis indicated that (1) methodologies used to estimate costs were significantly different among watersheds, and (2) that some cost information included in the lists was very preliminary and needed further refinement. The conclusion was that greater work was needed to upgrade cost estimates than was originally anticipated, with particular emphasis on development of reliable unit costs by project category.

Cost estimates were made based on an application of a range of unit costs per appropriate areal units (per acre, square foot, lineal foot, etc.). Unit costs were derived based on credible project estimates from the Upper Columbia, the experience of staff, and other source materials, including the ***Primer on Habitat Project Costs*** developed for the Puget Sound salmon recovery plan.

Meetings were held in each of the five watersheds of the Upper Columbia Basin to review and refine the unit cost table and to identify the size of projects that lacked the units needed to calculate costs. Meetings were held with project experts in almost all of the cost categories to discuss the appropriate units, the range in unit costs, and the factors responsible for costs being in the high or low segment of the range. The initial estimates and additional feedback from the watershed meetings led to the unit costs found in **Table 6.1**.

The project-by-project estimate of costs envisioned in the original proposal was clearly impractical because of the complexities of collecting project-specific information on each of the 400+ projects in the plan. The focus shifted to identifying average characteristics within each of the 29 categories of projects. The concept underlying this approach is that the extremely costly projects within the category will be offset by the extremely inexpensive ones, and that they will congregate around an average. This approach lacks the precision of a project-by-project analysis, but should suffice for the costs of the overall plan, the focus of this study.

Costs were then estimated for nearly every project in each category. Estimates were characterized in one of four categories:

- Projects with highly credible project-specific costs based on watershed sources;
- Projects with credible project-specific costs based on original cost estimates;
- Projects with credible project-specific costs based on unit costs and project size;
- Projects that lack the specificity needed for project-specific estimates but that are estimated based on the average size or cost of other projects in the category.

The aim in this exercise was to have enough projects in the first three categories to appropriately "calibrate" the average cost by category. One category – water quality source control – had insufficient information to allow any credible cost estimation, and will need further specificity. In addition, approximately 20 individual projects were so loosely defined as to make cost estimation impractical. Through use of these methods, the projects with reliable size and unit cost data rose from 10-15% of the total in the initial watershed lists to more than 50% in the final estimate and the number of projects with no cost information declined from 35-40% to fewer than 10%.

Although acquisitions[141] as a tool for habitat protection are not identified in the recovery plan, the UCSRB recognizes that acquisitions are occurring throughout the Upper Columbia. The estimated cost for acquisitions and maintenance of those acquired habitats was derived by considering funds historically spent on restoration and on protection. (Innovative land management techniques, best management practices, conservation easements, transfer of development rights, habitat farming agreements, and partnerships with private land owners need to be emphasized.)

6.2 Estimated Economic Benefits

Salmon and steelhead recovery will contribute to economies at the state, regional, and local levels (USDI et al. 2003). This contribution regularly exceeds the cost of salmon recovery and the economic impacts of traditional resource industries in small rural communities (Reading

[141] In general, acquisitions are not supported by the counties, because of the large amount of land currently under public ownership, removal of lands reduces the tax base, loss of economic activity, and the cost of long-term maintenance. However, the UCSRB recognizes that land acquisitions may be a tool needed for recovery if used properly and coordinated with local authorities. Other options, such as best management practices, easements, land swaps, and partnerships with private landowners should be emphasized.

2005). Many forms of investment and economic benefits are associated with salmon and steelhead recovery, including angling and its associated ancillary expenditures. In fact, over 40 categories of direct expenditures are associated with healthy (recovered) fish populations.

Economic studies have shown that restoring healthy runs of naturally produced salmon will benefit the regional economy (Institute for Fisheries Research 1996). For example, with a restored salmon fishery, Idaho alone would see almost half a billion dollars in economic benefit from sport fishing. Similarly, restored fisheries in Washington and Oregon would raise the total to almost $6 billion dollars in economic benefit to the region. In addition, the Pacific Coast Federation of Fishermen's Association estimates that restoration of Columbia and Snake River salmon would net the region an additional $500 million per year in commercial fishing revenue and as many as 25,000 new family-wage jobs (ECFF and PCFFA 1994).

In preparing to estimate economic benefits for the Upper Columbia region, recovery planners reviewed over 19 pertinent reports, most of these from published literature and nationally sanctioned reports. Additionally, experts from the Economics Department at Eastern Washington University, natural resource agency staff, and an economist from NOAA provided expert advice. The findings substantiate that in addition to direct and indirect dollars derived from tourism-related activities, an entire industry of family-wage jobs exists around salmon and steelhead recovery. In addition, a host of intrinsic benefits, such as increased property values and benefits emanating from reduced regulatory burden adds to the economics equation in tangible ways.

As described in Appendix K1, 9,586 jobs are created for Washington State citizens and that $854 million are spent each year on fishing-related activities. Using recent angler and catch data, and a comparable study from the Snake River Basin, the economic benefit to the Upper Columbia region could reach $43-$70 million per year. The Snake River basin estimated nearly $60 million in local economic benefit between 1999 and 2001.

As an example, in 2001, 938,000 anglers fished for salmon and steelhead in Washington State. These anglers spent about 5.4 million angling days and $386 per trip with each trip lasting an average of 1.3 days (USDI et al. 2003). Total expenditures exceeded $2,000 per fish harvested by including direct and indirect expenditures. However, because expenditures are incurred even when fish are not harvested, number of angling trips, whether fish are harvested or not, is the most appropriate metric in the economic equation and the final measure of economic benefit used in this plan. Salmon recovery can be viewed as an investment and an opportunity to diversify and strengthen the economy. Importantly, the general model for viewing cost versus benefits must be viewed in terms of long-term benefits derived from short-term costs.

6.3 Economic Impacts of Agriculture in North Central Washington

Agriculture is a resource-based enterprise that both draws from and enhances the natural and economic environment in the three counties of North Central Washington (NCW). All three counties are economically dependent on industries that are resource-centered: agriculture, logging and mining (the latter two in Okanogan County, primarily).

Tree fruit production is common to all three counties as the leading industry, although its makeup is not identical in all three counties. Livestock is common to Douglas and Okanogan; cereal grains are dominant in the plateau areas of Douglas County while mining is mainly found in Okanogan County.

Analysis of the impact of agriculture on NCW is difficult because of the lack of study data that accurately reflects the cumulative, interdependent nature of multipliers that impact other sectors of the economy. For this plan, one study of the tree fruit industry in NCW (Jensen 2004) was identified. The Washington Horticultural Association and the Washington Research Commission, which looks at the total impact of the tree fruit industry across economic sectors in each county and as a unit, compared to other Fruit Reporting Districts (FRDs), as well as all of Washington, Oregon and Idaho. Additionally, a WSU economics student's Master's thesis (Potter 2004) examines the economy of Okanogan County from the perspective of its resource-based industries, their exports, and their role as the driver of Okanogan's economy. Both of these studies will be cited extensively here. No study was identified that examined the economic impact of agriculture in Douglas County with implications across the various sectors of that economy.

One factor that changed forever the landscape, economy, and social structure of NCW is the introduction of irrigation water for agriculture. Without water, most of NCW would more closely resemble a desert than the center of the state's fruit production. While this seems such an obvious fact, it cannot be overlooked when estimating the economic value of the agricultural enterprise that resulted from the introduction of irrigation to the region. To fairly determine agriculture's economic impact, even the casual observer will realize that the very fabric of life in NCW is rooted in the agricultural products that are grown, processed, sold, and exported to the rest of the country and around the world. Whether examining retail sales, real estate or any other sector of the economy, it is all indebted in some way to the area's economic engine: agriculture. Employment in Agriculture (farm workers/owners) has actually increased at a rate faster than the national average for farm employment in each of the three counties of NCW (National Income Indicators Project [NIIP] 2005).

6.3.1 Situation

Okanogan is the largest county of the state but has a relatively low density of 7.5 persons per square mile (Washington) – indicative of the large amount of land (70%) that is not in private ownership and the land involved in the resource-based industries of agriculture, logging and mining (Okanogan). Livestock numbers for Okanogan County in 2005 were slightly under the five-year average of 49,500, totaling 47,500—yet this was enough to make it the leading livestock producer in the state, with an average value per head of $94/cwt (Washington Agricultural Statistics Service [WASS] 2005). Tree fruit production is the leading economic factor in the county, with 25,346 acres (WASS 2005); agriculture in total, directly accounted for a 20.4% share of the total employment (NIIP 2005) but just 16.67% of wages earned (Washington Employment Security Department [WAESD]). Mining contributed less than 1% of the county employment in 2005 and has been in decline for the past several years (Potter 2004).

Douglas County's economy is dominated by agriculture; livestock, cereal grains and tree fruits are the primary agricultural enterprises, accounting for a 22.2% share of all employment (see NIIP) and 15.26% of wages earned in the county (WAESD). The county had about 11,000 head of cattle and calves, 4,500 acres of hay, 199,800 acres for all cereal grains (mostly non-irrigated) and 14,901 acres of tree fruits (WASS 2005). The CRP program in Douglas County, with nearly 186,000 acres enrolled, has drastically reduced soil erosion and sedimentation. Before implementation, loss from rainfall runoff averaged 7.4 tons per acre per year (Foster Creek Conservation District). After putting lands into the CRP program that number has been reduced to practically zero, 0.56 tons/acre (Foster), improving water quality for all the creeks in Douglas County: Foster, Pine, Douglas, McCartney, and Rattlesnake for the Columbia River and Banks Lake (Bareither).

Chelan County's economy is somewhat more diversified outside of the resource-based sectors, but still dominated by agriculture, primarily tree fruit production on 37,212 acres (WASS 2005). Total fruit production has increased over the past thirty years (Smith 2005). On-farm jobs in Agriculture accounted for a 9.1% share of the total county employment in 2003 (NIIP 2005), but accounted for nearly 12% of total wages in the county (WAESD).

6.3.2 Economic Impacts

The total employment in NCW that is directly and indirectly related to all agriculture is not available in any study identified. The generally accepted multipliers of employment impact on the other sectors of the economy range from 1.5 to 2.3 to account for employment "ripples," but even these would not adequately account for the situation where agriculture is such a dominant feature of the economy.

Employment multipliers for agriculture in NCW:

County	***Ag's Share***[142]	***at 1.5***	***at 2.3***
Okanogan	20.4	30.6	46.92
Douglas	22.2	33.3	51.06
Chelan	9.1	13.65	20.93

While showing this range of employment share for each county gives a more balanced picture of agriculture's impact across all the sectors of the economy of each county, it is also useful to examine a specific example. Employment at fruit packing sheds is not included in the number given for agricultural employment. Nevertheless, according to Schotzko and Smith (2002), "[a]dditional employment caused by the existence of the packing industry is about 3,090 jobs, a ratio of about 1.41. In other words, for every job in the warehouse, another .41 jobs is required either in terms of providing production inputs to the warehouses (other than fruit) or in those sectors supporting the lifestyles of the employees. So, in addition to the 7,500 jobs in the warehouses, there are another 3,090 jobs in related industries or in the local communities that are due to the existence of the warehouses."

In another example, the retail sales sector of the economy accounts for 18% of employment in Chelan County (WAESD), but there is no accurate way to measure how much of that is related to sales of agricultural machinery, supplies, or services since that breakout is not available in current data. The economic impact of agriculture in NCW is obviously much larger than is indicated by the usual breakout of sector data used by the census and other statistical analyses.

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[142] (NIIP), National Income Indicators Project, Smith, Gary, PhD, ***"Shift-Share Analysis Results"*** for Chelan, Douglas and Okanogan Counties, http://www.pnreap.org/Washington/shift-share.php, Accessed August 2007.

In Okanogan and Douglas Counties, livestock is a major portion of the agricultural picture. Okanogan dominates the region with the sale of 24,548 head of cattle and calves compared to 6,204 in Douglas County for 2002 (WASS 2005); the estimated value of the combined counties' industry sales in 2002 was $17.2 million (WASS 2005). For the same year, cereal grains (wheat, barley and oats) plus hay acreage (excluding haylage, grass silage, and greenchop) in Chelan, Douglas, and Okanogan counties totaled 242,161 acres (WASS 2005) with an approximate combined farmgate value of $37,673,060 (Appendix K2). No exact figure for these values exists because of the price variations during the season for these products as well as the proprietary nature of some reporting. Rental payments for CRP contracts in 2005 for Douglas County equaled $8,390,894.

The dominant agricultural enterprise in all three counties is tree fruit production, consisting primarily of (in order of magnitude) apples, pears, cherries, peaches, apricots, nectarines, plums/prunes, and juice culls (Jensen 2004).

Tree fruit acreage in NCW	Total Acres (WASS)	Bearing Acres (2004 – Jensen)
Chelan:	37212	27253
Douglas:	14901	14064
Okanogan:	25346	21729
TOTALS:	77,459	63,046

Keeping in mind that 30% of the tree fruit bearing acres in the state of Washington are in the three counties of NCW, and to better understand the magnitude of the industry, Appendix K2 shows the production of apples only in Washington relative to the rest of the country. Appendix K2 shows Washington State's dominance in farmgate value among the Northwest states of Oregon (11%), Idaho (2%) and Washington (87%). The estimated impact of the tree fruit industry's income (as depicted in an input-output model of analysis) on the state of Washington is **$2,842,333,172[3].** The impact on the economy of NCW alone is accounted for in the following listing of impacts reaching across the broad sectoral categories (Jensen 2004).

NCW Impact Results:

Direct and Indirect Purchases by Business Sectors	$154,473,468
Total Household Income of Owners and Employees	444,297,553
Local Business Sectors Impacted by Household Expenditures	199,728,201
Total Economic Income Impact to Region	**$798,499,222**

Appendix K2 examines the impact of tree fruit agriculture in NCW extrapolated to the other sectors of the economy using IMPLAN data and applying the input-output model of analysis. One of the categories listed is "Other," and is explained as, "an array of the distribution of local household spending as an estimate of household spending on goods and services from outside the region (imports). These imports from outside the region are an important consideration for economic development opportunities."

Another area of impact is that of the income to local government in the form of property taxes flowing to city and county general funds. The only estimate that was identified taking into account the comprehensive impact of the tree fruit industry was that found in a study in 2004 done by Tom Schotzko and Tim Smith (WSU Extension, personal communication) that focused on the apple industry, but in this one measure, spoke more broadly about the larger tree fruit industry impact that included warehouses: "The combined estimate of property taxes paid by growers and warehouses, and the property tax payments generated as a result of the total economic impact of the industry is over $30 million per year. Those dollars support schools, roads, fire and police services and local government, etc." (Schotzko and Smith).

6.3.3 Analysis

Combining the value of the major agricultural enterprises in NCW, it is easy to understand the importance of these industries on the regional economy. Studies such as the one conducted on the impact of grazing cattle near riparian zones are critical in finding measures that satisfy the need to restore and maintain a healthy environment while also allowing a major agricultural enterprise to stay healthy. That study, for example, shows that, "As riparian utilization becomes more restrictive, providing off-stream water and salt may be a way that traditional grazing levels can remain while environmental objectives (reduced livestock impacts in the riparian area) are also obtained."…"initial ecological assessments…may show improvements in riparian area health" (Stillings et al. 2003). Other research has demonstrated that, "Implementing offstream water and trace-mineral salt into a grazing system can be effective in altering distribution patterns of cattle grazing a riparian meadow and its adjacent uplands and also can result in increased weight gain" (Porath et al. 2002).

While seeking the funding and other resources to achieve an environmental goal it is also necessary to fund the research that will find the ways that allow agriculture to thrive at the same time. Studies such as the two referenced above, demonstrate that discerning the best mitigation practice to achieve the necessary environmental goals is not incompatible with good agricultural practices. The key is to use good information that is research based.

To help understand the relationship between the amount of water flowing in a river and the amount of water needed for agriculture, Appendix K2 shows the amount of water used by one acre of fruit trees in one day, then for an entire season, taking into account the differences for cool, average and warm temperatures. Additionally, it indicates that additional water requirements must be added to that used by trees to account for the inefficiencies of most irrigation systems: compensating for soil differences and dry spots within the unit, loss of water in the irrigation delivery system, evaporation, etc.

A significant difficulty when discussing irrigation requirements is that agricultural scientists and natural resource scientists use two different measuring systems to account for the same resource: water. Agriculture measures the quantity of water used or needed in terms of the amount of water applied evenly to one acre of land in either inches or feet, termed Acre Inches (Acre in) or Acre Feet (Acre ft). Natural resource scientists measure the quantity of water moving down a river in cubic feet per second (cfs) or (ft^3/sec).

The major difference is the agricultural scientist is measuring a static volume whereas the natural resource scientist is measuring movement of volume in time (seconds). How these two metrics correlate was not found in the literature search. With the help of WSU's water quality specialist, Robert Simmons, this gap can be bridged in the calculations noted on the end of Appendix K2 notes A - C. In step "D", the range of water needed for irrigation, including inefficiencies, is calculated to determine the total amount of water used per acre in one season by all commercial fruit trees in NCW. Considering the total cfs of all the rivers in NCW, the amount needed for tree fruits is small.

Acres of Tree Fruit	Water needed in one season **(Ac in)** average temps	Water needed in one season **(cfs)** average temps	
		15% inefficiency	40% inefficiency
1	33.45	0.004425435	0.005388795
77,459 acres[143]	2,591,003.5	342.79	417.4

A more productive dialogue is possible when we bring together these three pieces of information: the amount of water used each month by an acre of fruit trees with irrigation inefficiencies, the conversion of this amount to cfs and monthly stream flow data. Most irrigation begins in mid-March and concludes by mid-October. The heaviest use comes in July and August when temperatures are normally highest (Appendix K2).

Appendix K2 shows the water requirements for 10,000 Acres of fruit trees. This unit of trees will allow most irrigators to determine the water needed for their districts, while the cfs number for this unit of trees can be used by natural resource agencies to more easily calculate the amount of water diverted to irrigation from any given stream, river or watershed.

Using data for the Wenatchee River at Monitor, Appendix K2 shows that each block of 10,000 acres uses less than 4% of streamflow during July and about 10% during August.

6.3.4 Conclusion

The economic studies identified either examined just one aspect of agriculture in NCW or only looked at one county. Broad statistical summaries, such as the Census of Agriculture, the Washington Agriculture Statistics Service, and the WSU National Income Indicators Project were all limited either in their scope or in their ability to cut across economic sectors to show a more accurate picture of the role played by agriculture in NCW. IMPLAN data, while obviously available, could provide this analysis, but has not been used for such a study to this point.

Combining the value of the agricultural enterprises in NCW as identified in this examination, yields the following summary:

Ag Enterprise	Annual Impact	Counties Included
Tree Fruits	$798.5 Million	Chelan, Douglas, Okanogan
Livestock	$17.2 Million	Douglas, Okanogan
Cereal Grains	$46.1Million	Douglas, Okanogan (includes CRP Pymts)
	$861.8 Million	TOTAL IMPACT IN NCW

Using the minimum economic multiplier factor of 1.5, we arrive at an estimated total impact of $1.3 Billion for the economy of NCW for one year from all agricultural activity across sectors.

[143] This number represents the total of all the tree fruit acreage in Chelan, Douglas, and Okanogan counties, combined, in 2005 (WASS).

Table 6.1 Estimated cost of salmon habitat restoration activities in the Upper Columbia Basin, listed by restoration category

Category	Annual Cost	Total Cost
Acquisitions and maintenance		$100,000,000
Conservation Easements		$34,317,000
Undefined Passage Barriers		$1,750,000
Culvert Repairs/Replacements		$4,850,000
Dam/Diversion Retrofits		$2,150,000
Range Management		$960,000
Fencing		$202,000
Large Woody Debris Placement		$3,047,500
Mainstem Channel Enhancement		$4,850,000
Mainstem Floodplain Restoration		$18,775,000
Riparian Restoration		$3,594,600
Tributary Channel Enhancement		$1,920,000
Tributary Floodplain Restoration		$19,280,000
Road Maintenance	$1,540,000	$15,400,000
Road Reconstruction		$17,160,000
Road Decommissioning		$1,205,000
Fish Screening		$1,231,000
Nutrient Enhancement		$132,000
Water Quality Source Control		TBD
Instream Flow		$1,718,000
Protection		
Irrigation Efficiencies		$14,415,000
Water Storage		$120,000
Well Development		$3,420,000
Miscellaneous Water Quantity		$250,000
Wildlife Management		$850,000
Education	$775,250	$7,752,500
Incentives		TBD
Major Studies and Assessments		$10,750.000
Moderate Studies and Assessments		$2,845,000
Minor Studies and Assessments		$2,370,000
Monitoring	$980,000	$9,800,000
Program Management	$1,105,000	$11,050,000
TOTAL		$296,164,600

7 Relationship to Other Efforts

There are a number of conservation and watershed planning efforts in varying stages of development and implementation that directly or indirectly protect or improve the viability of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Described in this section is the relationship of this plan to other conservation efforts within the Upper Columbia basin. As noted earlier, this plan built upon the foundation established by these efforts and adopted portions of those plans where appropriate.

Some of the efforts currently being developed or implemented in the basin include the mid-Columbia HCPs for the operation of Wells, Rocky Reach, and Rock Island dams; Biological Opinions on the mid-Columbia HCPs; the Federal Columbia River Power System Biological Opinion and Remand; Biological Opinion on the operation of Priest Rapids and Wanapum dams; Hatchery and Genetic Management Plans (HGMPs) for federal hatcheries; Biological Opinions on the operation of state hatcheries (designed for PUD mitigation); the USFWS Bull Trout Draft Recovery Plan; U.S. Forest Service Northwest Forest Plan; Biological Opinions on Federal Actions (USFS/BLM land management activities); Okanogan Initiative; Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon), The Tribal Salmon Restoration Plan; Columbia River Partnership; Washington State Forest and Fish Agreement; NPCC subbasin plans; Watershed Planning under RCW 90.82; the Lead Entity process under RCW 77.85; local comprehensive and shoreline management plans and Natural Resource Conservation Service and County Conservation Districts conservation efforts.

Any material added to this plan must be reviewed by the Board.

8 Plan Implementation

Implementation of the Proposed Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan involves addressing data gaps through research, monitoring, and evaluation; establishing schedules; engaging stakeholders and landowners; identifying responsibilities; and securing funding. Many of these elements are described in this section.

8.1 Implementation Structure

The implementation structure for the recovery plan is diagramed in **Figure 8.1**. The role of each entity is described below.

8.1.1 Upper Columbia Salmon Recovery Board

The goal of the UCSRB is to strive to implement the plan in a voluntary manner. The UCSRB is the coordinating body for the Recovery Plan. Additionally, the UCSRB will facilitate improvements in resources and authorities for the region to assist in plan implementation, such as technical assistance, funding mechanisms, permitting, monitoring and outreach. The UCSRB will hire an Implementation Leader to act as the primary point of contact for the UCSRB and attend meetings as necessary.

This is a complete Implementation Structure and includes components that the UCSRB is not currently requesting funding for (M&E, Lead Entity funded activities and adaptive management efforts).

8.1.2 Implementation Process Elements

The primary functions are to facilitate the implementation, monitoring, and adaptive management processes at specific check-in dates outlined in the recovery plan or as deemed necessary by the Implementation Team and/or the Upper Columbia Salmon Recovery Board.

8.1.3 Roles and Responsibilities of the Implementation Team

A single dedicated team is needed to help ensure that the plan is implemented. The team is composed of an Implementation Team Leader (to be determined), three Lead Entity representatives (one for each County), the Regional Technical Team, local, state, NOAA Fisheries and other federal agencies, tribal resource management agencies, local stakeholders, and others. This is not part of any regulatory/enforcement function by any agency. Also, this process does not include land-use planning processes by counties and cities. The Growth Management Act and Shoreline Management Act along with related SEPA processes have defined review and administrative procedures in state law and local jurisdictions will continue to follow those procedures.

Tasks/Responsibilities

- Track the progress of the Recovery Plan. Identify milestones, benchmarks, dates, and sequencing for the list of essential tasks (the first Implementation Team deliverable). The group will meet quarterly. Assignments to individual members or subcommittees will be based on tasks.
- Prepare progress reports for NMFS, USFWS, GSRO, the UCSRB, and the public. Provide all plan information via a dedicated web site.
- Incorporate work from the Regional Technical Team to help implement the necessary monitoring and analysis actions are occurring in the region and that they are consistent with the required performance standards and metrics leading to delisting or reclassification.

Watershed Action Teams (WAT)

A local group for each watershed – referred to as a "Watershed Action Team" – will work with the UCSRB to update the implementation schedules in the plan as a component of an adaptive management framework for recovery. The UCSRB will facilitate monitoring and evaluation efforts so that the data that are collected are consistent across the region.

The Watershed Action Teams were asked to nominate a representative to participate in a regional "Implementation Team." This group will be charged with coordinating funding sources, coordinating implementation schedules across the region and coordinating monitoring and adaptive management of the plan. The UCSRB implementation structure is identified in **Figure 8.1**.

Public Involvement

It is essential that opportunities for the public to be involved in partnership with resource managers are built into this plan. This partnership will be necessary to implement the recovery actions in a well-organized manner with the ultimate goal focused on recovery of the species in an economically sensitive and timely manner. The UCSRB recommends that the WAT be used as the primary public involvement component for reviewing projects and planning in their respective communities.

In addition, the Implementation Team as a whole will work on the following tasks:

- Provide information to each subbasin for providing public involvement activities (assist monitoring program, host and maintain Recovery Plan web site). The group will work closely with watershed planning groups and Lead Entities, RTT, and the UCSRB Board.
- Attend RTT Analysis Workshops in 2009, 2012, 2015, and every third year thereafter to provide information and data to assess the plan's progress. Present information at UCSRB meetings and to resource managers.
- Host local Adaptive Management Workshops—workshop to accept all proposals for changes to the plan in 2009, 2012, 2015, and every third year thereafter. UCSRB Board will resolve changes.

In order for this Plan to be effective in achieving its goals, it needs to be used and useful in providing guidance to relevant entities and processes. The implementation process should provide timely communication and interaction between the UCSRB, NOAA Fisheries, and other entities and processes in order to be influential and, ultimately, successful.

To facilitate the implementation of this plan, the UCSRB suggests the Implementation Team coordinate through a process such as the following framework.

Conceptual Framework:

- Project sponsors need to develop project goals, funding, permitting, legal and technical requirements.
- Local watershed citizen groups (e.g., Watershed Action Teams) engage in planning processes before project development resulting in project concepts that have a high probability of public support.
- Project concept is taken to the general public explaining project goals, funding, permitting, legal and technical requirements, and processes to date involving local watershed groups.
- Based on public input and technical review, the project is refined and draft plan is developed in consultation with local watershed citizen groups (e.g., Watershed Action Teams).

8.1.4 Regional Technical Team (RTT) Roles and Responsibilities

The RTT shall consist of persons with appropriate technical skills, who shall be appointed by the RTT chairperson, in consultation with the UCSRB Board. The RTT will function under its current operating procedures.

The RTT will have three committees including monitoring and evaluation, project review, and program review. RTT meetings are open to the public except for administrative issues.

The RTT is responsible for the technical review of the recovery plan implementation, project proposals, and research, monitoring & evaluation efforts.

8.1.5 Lead Entities

The Lead Entities, under Washington State Law, are responsible for the development of the prioritized lists of projects. The prioritization process includes the Citizen Committee and RTT review and recommendations.

8.2 Uncertainties

There are currently several major “unknowns” or “uncertainties” regarding implementation of this plan, including policy, legislation, and science. This section describes information/data gaps and discusses ways to address them.

8.2.1 Policy and Legislative Uncertainties

There is some uncertainty associated with long-term funding and authorization of actions identified in this plan. Funds from the SRFB and through the HCP process (Tributary Fund) are insufficient for the large-scale actions proposed in this plan. Funds from other sources will be required if the complete Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan is to be implemented.

The application procedures for funding under BPA's Fish and Wildlife Program or the SRFB are complex and lengthy processes. The procedures are completely different and there is no reciprocity between the processes. It is recommended that BPA, the Interagency Committee for Outdoor Recreation (IAC), HCPs Tributary Fund, and SRFB standardize their application processes so that funding of recovery actions for Chinook, steelhead, and bull trout can be streamlined to the extent possible.

Finally, assurances are needed that good-faith recovery efforts based on best scientific information available will absolve the public of culpability in regard to adverse affects on ESA-listed species. In other words, if an entity has corrected problems (threats) that have been identified as detrimental to salmonids, there must be a point at which they are no longer responsible for salmonid population problems. Currently, under ESA, assurances are legally guaranteed only under Section 7 and Section 10. The UCSRB encourages the federal agencies to explore additional opportunities for assurances. A legally binding definition of discharge of responsibility for impacts to Chinook, steelhead, and bull trout populations would increase considerably voluntary participation in recovery planning, coordination, and implementation.

8.2.2 Scientific Uncertainties

Data gaps important to recovery can be divided into two major categories: (1) those that deal with critical uncertainties and (2) gaps in knowledge about the linkages between specific actions and their effects on habitat factors and VSP parameters. Some of the data gaps can be filled through monitoring and evaluation; others must be filled through research.[144]

As described in Section 3.12 and throughout Section 5, unknown aspects of environmental conditions vital to salmonid survival are termed "critical uncertainties." In this plan, critical uncertainties are a major focus of the research, monitoring, and evaluation program (Section 8.2).

Monitoring is needed to establish linkages between specific actions and resultant environmental effects. Those linkages are complex and often not well understood. Understanding them requires input from experts from various fields. It is important that the actions recommended in this plan to benefit listed fish species in the Upper Columbia Basin be reviewed by fish ecologists, geologists, hydrologists, and other experts familiar with the recovery region.

8.3 Monitoring and Adaptive Management

Monitoring is needed to assess if actions recommended in this plan achieve their desired effects. There is a risk that the recommended actions may not be adequate to achieve the goals of the plan. To manage that risk, this plan includes critical monitoring and evaluation to assess whether actions are having the predicted results and to provide information for assessing the biological status of the species addressed.

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[144] It is important to distinguish between monitoring and research. In simple terms, monitoring measures change, while research identifies the causes (mechanisms) of the change. In some cases, both monitoring and research have very similar statistical and sampling designs, differing only in their objectives.

As part of implementing the Upper Columbia Spring Salmon and Steelhead Recovery Plan, a detailed monitoring and evaluation program will be designed and incorporated into an adaptive management framework based on the principles and concepts laid out in the NMFS guidance document, ***Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance (***available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm).

Designing an effective monitoring program for salmon recovery involves the following initial steps:

- Clarify the questions that need to be answered for policy and management decision making, including the entire ESU, DPS, and salmonid life cycle.
- Identify entity or entities responsible for coordinating development of this program.
- Identify:
    - Which populations and associated limiting factors to monitor
    - Metrics and indicators
    - Frequency, distribution, and intensity of monitoring
    - Tradeoffs and consequences of these choices
- Assess the degree to which existing monitoring programs are consistent with NMFS guidance (e.g., Upper Columbia Monitoring Strategy; Okanogan Basin Monitoring and Evaluation Program; Draft Monitoring and Evaluation Plan for PUD Hatchery Programs; FCRPS monitoring actions; estuary monitoring programs).
- Identify needed adjustments in existing programs, additional monitoring needs, and strategy for filling those needs.
- Develop a data management plan (See Appendix B of the NMFS guidance document).
- Prioritize research needs for critical uncertainties, testing assumptions, etc.
- Identify entities responsible for implementation.

For further discussion about designing a monitoring and evaluation program, see Appendix P.

Monitoring and evaluation are designed to test implementation, validation, status/trend, and effectiveness. Implementation monitoring determines if planned actions were implemented as intended and whether all implementation objectives are on schedule. Validation monitoring determines whether the fundamental ecological assumptions underlying the recovery plan are true. Prominent among these assumptions are the effects of specific environmental conditions on survival and abundance of listed fish species as embodied in the EDT model. Status/trend monitoring determines the current conditions (status) of the ESU and DPS (based on assessment of their component populations and major population groups), of the threats to the ESU, DPS, and populations (or the factors limiting ESU and DPS recovery), and of the changes in ESU and DPS and threat status over time. Effectiveness monitoring focuses on whether recovery actions changed the environment and/or the VSP parameters of listed fish species as predicted by the plan.

In addition to monitoring implementation, status and trends, and effectiveness within the Upper Columbia Basin, monitoring and evaluation will also address actions implemented and the status of threats and limiting factors downstream from the mouth of the Yakima River. That is, monitoring and evaluation must address the full life cycle of the listed fish and all threats and limiting factors. Factors outside the Upper Columbia Basin will have a significant effect on the success of recovery of Chinook and steelhead in the Upper Columbia Basin. These factors include commercial harvest, sport and tribal harvest, conditions in the mainstem Columbia River (including hydroelectric operations), and conditions in the estuary and ocean, including short and longer-term cycles in ocean conditions.

The Board recognizes that monitoring and evaluation of actions implemented within this plan are critical to the success of recovery. The Board fully expects State, Federal, and other entities to fund monitoring and evaluation of restoration actions.

8.3.1 Implementation Monitoring

Recovery actions implemented within the Upper Columbia Basin will be monitored to assess whether the actions were carried out as planned. This will be carried out as an administrative review and will not require environmental or biological measurements.

Implementation monitoring will address the types of actions implemented, how many were implemented, where they were implemented, and how much area or stream length was affected by the action. Indicators for implementation monitoring will include visual inspections, photographs, and field notes on numbers, location, quality, and area affected by the action. Success will be determined by comparing field notes with what was specified in the plans or proposals (detailed descriptions of engineering and design criteria). Thus, design plans and/or proposals will serve as the benchmark for implementation monitoring. Any deviations from specified engineering and design criteria will be described in detail.

8.3.2 Status/Trend Monitoring

The status and trend of spring Chinook, steelhead, and bull trout and their habitats will be monitored throughout the Upper Columbia Basin following the guidelines in the Upper Columbia Monitoring Strategy (Hillman 2004).[145] Within each subbasin, status/trend sampling sites will be selected according to recovery plan priorities and the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) design, which is a spatially balanced, site-selection process developed for aquatic systems and recommended within the Upper Columbia Monitoring Strategy. This approach has been used successfully within the Wenatchee subbasin (under the Upper Columbia Monitoring Strategy) and in the Okanogan subbasin (under the Okanogan Basin Monitoring and Evaluation Program). The Upper Columbia Monitoring Strategy describes in detail the approach, indicators, and protocols needed to assess

[145] The Upper Columbia Monitoring Strategy was implemented within the Wenatchee subbasin as a pilot study in 2004. The strategy will be refined as new information becomes available through the pilot study and through other monitoring programs (e.g., Okanogan Basin Monitoring and Evaluation Program).

status and trends of listed fish species and their habitats in the Upper Columbia Basin. This strategy will be updated annually as new information becomes available. Further assessment is needed to evaluate if the Upper Columbia Monitoring Strategy is consistent with NOAA guidance and sufficient to measure the viability attributes and limiting factors for the listed ESU and DPS.

8.3.3 Effectiveness Monitoring

Not all recovery actions recommended in this plan need to be monitored for effectiveness. As noted in Section 5.5, only three replicates of each habitat restoration "class" implemented within each subbasin is needed to assess effectiveness. Habitat classes and their associated "specific" actions are listed in **Table 5.8**. To the extent possible, effectiveness of recovery actions will be monitored using the Before-After-Control-Impact (BACI) design with stratified random sampling, as described in the Upper Columbia Monitoring Strategy (Hillman 2004). The Upper Columbia Monitoring Strategy describes in detail the approach, indicators, and protocols needed to assess effectiveness of habitat restoration classes. Hatchery actions will be monitored according to the Draft Monitoring and Evaluation Plan for PUD Hatchery Programs (Murdoch and Peven 2005). It is also critically important to coordinate these effectiveness monitoring programs with status/trend monitoring and effectiveness monitoring within the Hydro sector.

8.3.4 Research

As noted earlier, unknown aspects of environmental conditions vital to salmonid survival are termed "critical uncertainties." In this plan, critical uncertainties are a major focus of research. Critical uncertainty research targets specific issues that constrain effective recovery plan implementation. This includes evaluations of cause-and-effect relationships between fish, limiting factors, and actions that address specific threats related to limiting factors. Listed below are research actions that are needed to assess the effects of the uncertainties on recovery of listed fish species in the Upper Columbia Basin. Research actions address both in-basin and out-of-basin factors and are not all-inclusive. As part of plan implementation, these research actions will be prioritized.

Harvest

- Evaluate innovative techniques (e.g., terminal fisheries and tangle nets) to improve access to harvestable stocks and reduce undesirable direct and indirect impacts to naturally produced Upper Columbia stocks.
- Evaluate appropriateness of stocks used in weak-stock management.
- Develop better methods to estimate harvest of naturally produced fish and indirect harvest mortalities in freshwater and ocean fisheries.

Hatchery

- Assess the interactions between hatchery and naturally produced fish.
- Determine relative performance (survival and productivity) and reproductive success of hatchery and naturally produced fish in the wild.

- Assess if hatchery programs increase the incidence of disease and predation on naturally produced fish.
- Examine the feasibility and need of steelhead kelt reconditioning.

Hydro Project

- Evaluate if passage through hydroelectric projects affects reproductive success of listed fish species.
- Assess baseline survival estimates for juvenile listed fish species as they pass hydroelectric projects.
- Assess the effects of hydroelectric operations on juvenile and subadult bull trout survival.
- Assess the effects of temporary powerhouse shutdowns on the incubation success of steelhead in spawning gravels in the Chelan tailrace.

Habitat

- Implement selected restoration projects as experiments.
- Increase understanding of estuarine ecology of Upper Columbia stocks.
- Increase genetic research to identify genotypic variations in habitat use.
- Increase understanding of linkages between physical and biological processes so managers can predict changes in survival and productivity in response to selected recovery actions.
- Examine relationships between habitat indicators and landscape variables.
- Examine fluvial geomorphic processes to better understand their effects on habitat creation and restoration.
- Examine water balance and surface/groundwater relations (in the sense of Konrad et al. 2003), especially the benefits of aquifer recharge during periods of high runoff in appropriate areas. Using the results inferred from these studies, evaluate the effects of aquifer recharge on late summer and winter instream flows and resultant habitat use. Implement and document an aquifer recharge demonstration project in the Methow Basin by diverting excess water during times of high spring runoff through selected unlined irrigation ditches. Evaluate the effect of this action (with selected irrigation ditches to be designated as control) to enhance stream flows at critical times on spring Chinook salmon and steelhead habitat use.
- Test assumptions and sensitivity of EDT model runs.
- Evaluate nutrient enrichment benefits and risks using fish from hatcheries or suitable analogs.
- Assess population structure and size of bull trout in the Upper Columbia Basin.
- Assess the presence of bull trout in the Lake Chelan and Okanogan subbasins and upstream of Entiat Falls in the Entiat subbasin.

- Assess the effectiveness and feasibility of using fish transfers, range expansion, and artificial propagation in bull trout recovery.
- Examine migratory characteristics and reproductive success of bull trout.
- Describe the genetic makeup of bull trout in the Upper Columbia Basin.

Ecological Interactions

- Determine the effects of exotic species on recovery of salmon and trout and of the feasibility to eradicate or control their numbers.
- Examine consumption rates of fish (especially exotics) that feed on listed fish species.
- Determine the interactions and effects of shad on Upper Columbia stocks in the lower Columbia River.
- Determine the significance of marine mammal predation on Upper Columbia stocks and alternatives for management in the Columbia River mainstem and estuary.
- Assess the occurrence of resident bull trout populations and their interactions with migrant (fluvial and adfluvial) populations.
- Determine the effects of brook trout and bull trout interactions (competition, predation, and hybridization).
- Evaluate the interactions of bull trout with spring Chinook and steelhead.

8.3.5 Data Management

Because the indicators and protocols recommended in this plan are from the Upper Columbia Monitoring Strategy, this plan will incorporate the data dictionary and infrastructure being developed for that program. The data management program is being developed by the Bureau of Reclamation, Spatial Dynamics, Inc., and Commonthread, Inc., with input from State, Federal, and Tribal agencies and consultants. The data dictionary is a data management tool that provides a comprehensive conceptual framework based on the monitoring indicators and data collection protocols. The data dictionary will also include a geo-database (incorporating an ArcHydro Geodatabase Model) that will host GIS work (landscape classification information). The data dictionary will be used to develop field forms that crews will fill out during data collection.

Data will be compiled, analyzed, and reported using protocols developed by the Implementation Team. The protocols will allow easy access by the public, but data entry will be limited to authorized individuals identified by the Implementation Team.

Before new data management systems and protocols are developed, efforts will be made to coordinate with state and other regional systems to limit costs and improve the ability to roll up information for evaluation across the region. Project data management will be informed by the PCSRF data system, guidance from PNAMP’s effectiveness work group, and NOAA guidance.

8.3.6 Adaptive Management

Adaptive management has been defined in Washington State law as "reliance on scientific methods to test the results of actions taken so that the management and related policy can be changed promptly and appropriately" (RCW 79.09.020). It is described as a cycle occurring in four stages: identification of information needs; information acquisition and assessment (monitoring); evaluation and decision-making; and continued or revised implementation of management actions. Adaptive management is captured in the sequence: "hypothesis statement," "monitor," "evaluate," and "respond."

This plan has identified information needs and suitable monitoring programs. Evaluation will occur at three levels (**Figure 8.2**):

- **Scientific Evaluation**—An evaluation of available information by independent scientists to assess the strengths and weaknesses of the actions.
- **Public Evaluation—**An evaluation of available information by the public to assess and monitor socio-economic factors and impacts.
- **Decision-Making Evaluation—**An evaluation of available information by decision-makers, who determine what alternatives and management actions are needed when "triggers" are reached.[146]

The purpose for evaluation is to interpret information gathered from monitoring and research, assess deviations from targets or anticipated results (hypothesis), and recommend changes in policies or management actions where appropriate. Input from both independent scientists, stakeholders, and the general public are required. These groups will annually provide feedback to decision makers (UCSRB based on recommendations from the Implementation Team), who have the responsibility to change policies or management actions.

8.3.7 Check-In Schedule

The Upper Columbia Salmon Recovery Board with NOAA Fisheries and the USFWS will conduct mid-point evaluations, or "check-ins" in years 1, 3, 5, 8, 12, and every fourth year thereafter, following implementation. The first ***Check-In Report***, submitted one year after the plan begins to be implemented, will primarily address progress made towards obtaining funding, initiating studies, developing priorities, and other programmatic issues. To the extent possible, it will also provide updates to adult fish returns (spawners), abundance and abundance trends, and juvenile fish survival (including smolts/redd estimates). Later reports will detail research and monitoring results. If necessary, these results will be used to "adaptively" modify and prioritize the implementation schedule. The UCSRB acknowledges that rapid implementation of actions is key to the success of this plan.

It is important that the public and the agencies have confidence in the recommended recovery actions and in the science that supports the actions. Accordingly, the Upper Columbia Salmon Recovery Board, working through the Implementation Team and technical workgroups, will obtain independent scientific review of its 3-, 5-, 8-, and 12-year evaluation reports. Beyond the

[146] Triggers and thresholds will be developed by the Implementation Team with NMFS and USFWS.

12-year check-in, independent scientific review will be under the discretion of the Upper Columbia Salmon Recovery Board and the Implementation Team.

8.3.8 Consistency with Other Monitoring Programs

An important aspect of this recovery plan is that it will rely on existing monitoring programs to evaluate the status/trend and effectiveness of recovery actions within the Upper Columbia Basin, to the extent that existing programs are consistent with NOAA guidance and are sufficient for recovery needs. Specifically, this plan incorporates by reference the Upper Columbia Monitoring Strategy (Hillman 2004), the Okanogan Basin Monitoring and Evaluation Program, and the Draft Monitoring and Evaluation Plan for PUD Hatchery Programs (Murdoch and Peven 2005). The former two address status/trend and effectiveness monitoring of habitat actions, while the latter addresses status/trend and effectiveness of hatchery actions. The PUDs currently have monitoring programs identified in their HCPs and Biological Opinions to address hydroproject actions. Actions implemented in areas downstream from the ESU and DPS will be addressed within the Action Agencies/NOAA Fisheries RME Program for the FCRPS Biological Opinion. This plan encourages these programs to continue.

The development of other regional monitoring programs may result in modifications to the monitoring programs used in the Upper Columbia Basin. These other programs, in various states of development, include the Bull Trout Recovery Monitoring and Evaluation Program being developed by the Recovery Monitoring and Evaluation Technical Group (RMEG), the Collaborative, Systemwide Monitoring and Evaluation Project (CSMEP), and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP). As these programs develop more fully, they will provide guidance on valid sampling and statistical designs, measuring protocols, and data management. This information may be used to refine and improve the existing monitoring and evaluation programs in the Upper Columbia Basin. The intent is to make monitoring and evaluation programs more consistent throughout the Columbia Basin and Pacific Northwest.

8.3.9 Coordination

Many entities have been or will be implementing recovery and other actions within the Upper Columbia Basin. It is critical that these programs be coordinated to reduce redundancy, increase efficiency, and minimize costs. Monitoring programs implemented within the Upper Columbia region include:

- Upper Columbia Monitoring Strategy,
- Okanogan Basin Monitoring and Evaluation Program,
- Action Agencies/NOAA Fisheries RME Program,
- Draft Monitoring and Evaluation Plan for PUD Hatchery Programs,
- Washington Salmon Recovery Funding Board Program,
- HCPs Monitoring Programs,
- Coho Reintroduction Monitoring Program,
- PACFISH/INFISH Monitoring Program,

- Pacific Northwest Interagency Regional Monitoring Program,
- USFWS, USGS, and BOR monitoring programs, and
- WDFW and Department of Ecology monitoring programs.

In 2004, the Upper Columbia Regional Technical Team (UCRTT) and its monitoring subcommittee began the process of coordinating monitoring activities in the Upper Columbia Basin. The UCRTT holds annual meetings with entities conducting monitoring activities within the Upper Columbia Basin with the purpose of coordinating activities and sharing information. The UCRTT is working to enhance coordination between the Upper Columbia Monitoring Strategy, the Okanogan Basin Monitoring and Evaluation Program, and other monitoring programs in the Upper Columbia Basin. These efforts have been beneficial and this plan encourages the process established by the UCRTT to continue. The UCRTT will also coordinate an assessment of the programs incorporated by reference into this plan to evaluate their consistency with NOAA guidance and their sufficiency for recovery.

8.4 Implementation Schedule

Recovery of listed species is a long process that requires sacrifice, patience, and courage. Because limited resources do not allow all actions to be implemented immediately, it is important to sequence actions according to their importance to recovery. This section of the plan describes a method for sequencing actions. Because of a lack of information, many details of the schedule remain undefined. For example, information is lacking on identification of response triggers, identification of milestones, and designation of management responses to triggering events. Nonetheless, general features of the implementation schedule can be described including the approach to prioritization of actions.

8.4.1 Sequence of Actions

This plan has identified a large number of recovery actions that need to be implemented within the Upper Columbia Basin. As noted earlier, resources are not currently available to implement all the recovery actions in the near term. Therefore, it is important to sequence or prioritize actions within and between all sectors. In this section, the plan identifies a general framework for sequencing recovery actions within the Upper Columbia Basin.

The framework categorizes projects or actions based on multiple objectives and characteristics. It also establishes a general model for selecting and implementing actions that will lead to recovery of Upper Columbia spring Chinook, steelhead, and bull trout. The approach is based on biological effectiveness and socio-economic feasibility. Actions listed in Appendix G will serve as the basis for project prioritization. ***This framework is intended as a guide. It is not intended to exclude any projects listed in Appendix G from implementation.*** This framework has been used successfully in the Entiat subbasin. The framework may evolve as new information from RME becomes available.

Project sequencing is organized into four general “tiers” of priority (Figure 8.3):

Tier I: Higher biological benefit; lower cost; higher feasibility

Tier II: Higher biological benefit; higher cost; lower feasibility

Tier III: Lower biological benefit; lower cost; higher feasibility

Tier IV: Lower biological benefit; higher cost; lower feasibility

The process of sequencing actions includes:

- Assigning a qualitative ranking of the biological benefits to each strategy. This ranking is based on how well each project addresses the VSP parameters.
- Rate the feasibility of each project. Criteria used to rate feasibility could range from professional and stakeholder input to an in-depth feasibility study. Criteria needed to describe feasibility should include at least: time to implement; constructability; acceptance by local governments; and acceptance by local stakeholders.
- Rate projects based on cost. Various methods can be used to estimate cost, but initially it can be quantitative.

After projects are rated on feasibility and cost, they are then compared to biological benefit. Those projects that are relatively inexpensive and ordered relatively high on feasibility and biological benefit will appear as Tier I projects. Tier IV projects have the lowest biological benefits and feasibility and relatively high costs. Projects in this tier should be implemented only if there are no projects within other tiers. Appendix L provides an example of the use of the prioritization framework.

Using this method, an implementation schedule for the Upper Columbia Basin was prepared (Appendix M). The implementation schedule is a living document that will be revised annually by the local habitat groups and the UCSRB and RTT.

8.4.2 Assurances of Implementation

The various levels of governments, tribes, non-governmental entities, and citizens have made commitments through participation in on-going and developing processes and participating in actions (projects) throughout the Upper Columbia Basin. In particular, the Upper Columbia Salmon Recovery Board has expended considerable political capital in developing this recovery plan by addressing difficult and sensitive issues. The success of this plan is dependent on the cooperation among agencies, entities, and citizens within and outside the region. The region has recognized that recovering spring Chinook, steelhead, and bull trout populations has positive effects to many aspects of the local quality of life.

8.5 Public Education and Outreach

The recovery of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin is dependent on the collective actions of the people in the region. Recovery cannot be accomplished through legislation, rules, or money. These are only tools for recovery. It depends on the cumulative effort of people working as individuals and collectively through and with organizations and governmental entities to achieve a common goal. In this case, the goal is the recovery of spring Chinook, steelhead, and bull trout to viable and sustainable levels. It must provide for the equitable sharing of burdens and benefits across affected interests and regions. Recovery will require fundamental changes in how we view, care for, and manage our fish, streams, and watersheds. A successful recovery program must work for people and fish. It must be sound biologically and technically and also be sensitive and responsive to regional and local cultural, social, and economic values. Documentation of public outreach efforts during the development of this plan is included in Appendix N.

8.5.1 Goal

It is a goal of public education and outreach to engage the public as an active partner in ***implementing and sustaining*** recovery efforts. This goal will be achieved by building public awareness, understanding, and support; and by providing opportunities for participation in all aspects of recovery implementation. The term "public" is intended to be inclusive of individuals, community groups, environmental and conservation organizations, businesses, agricultural interests, recreational interests, and others with a stake or role in achieving recovery.

Through a collaborative process, members of the public and scientists will exchange information and tools needed to effectively support and participate in recovery. This effort must continue so that support for recovery increases over time and integrates the continual changes in the local and regional environments. Recovery is sharing responsibility and requiring coordinated and complementary participation at the federal, tribal, state, local, and citizen levels.

8.5.2 Principles

Planning and implementation must be done in a collaborative and transparent manner with opportunities for the public to be fully engaged and involved at each step. Decisions for recovery of salmon and trout affect the future of all those who live and work in this region, so the counties are committed to understanding the diverse needs and concerns of the public, and to learning from experiences.

The dissemination of information should be thorough and a shared responsibility to enhance public education and to promote the broadest understanding of the region's needs. Additionally, existing information will be used to characterize community goals related to regional recovery planning and adaptive management including such aspects as economic development, land use, environmental perspectives, and social issues.

Public participation is a dynamic activity that requires teamwork and commitment. In developing this plan, it has become clear that engaging the interested citizen is challenging. Effective public participation and involvement requires building relationships. Local citizens have more confidence and ownership of local processes than regional processes.

8.5.3 Implementation

As noted above, public education and outreach is a responsibility shared by all implementation partners. Each implementing partner must have an effective public education and outreach effort tailored to its recovery responsibilities and the needs of its constituency. Each implementing partner must also be able to represent the regional recovery effort accurately and consistently and to put its actions in the broader context of the regional effort. While the purpose of these programs is to build awareness, understanding, support, and participation, multiple public education and outreach efforts also have the potential to overwhelm and confuse the public and to be repetitive and wasteful. Therefore, existing functional watershed groups/venues should be used as often as possible for information sharing.

The implementation approach relies largely on the individual implementing partners. It also identifies measures and actions to coordinate and integrate these individual efforts into an effective regional public education and outreach effort that will enhance consistency, avoid redundancy, and leverage efforts and resources.

A regional education and outreach program will be established to support, assist, and coordinate local efforts by implementation partners. The UCSRB in consultation with the implementing partners will develop the regional program. The program will be consistent with the principles discussed above and will:

- Develop and distribute informational and educational materials explaining the reasons for the recovery effort and the goals, strategies, measures, actions, and priorities of the recovery plan.
- Coordinate and facilitate communication and information sharing among agencies, governments, organizations, and the public. This will include a regional communications network, information clearinghouse, and identification of informational contacts for implementing partners.
- Identify opportunities for and assist implementing partners in integrating or consolidating similar, duplicative, or complementary education and outreach efforts. Provide the public with information on implementation actions throughout the region, including notice of opportunities to participate and information sources.
- Provide the public with information on the progress, status, and achievements of recovery actions throughout the region.
- Encourage and assist schools and educational organizations, such as conservation districts and WSU cooperative extension, to integrate salmon recovery into their environmental, agricultural, watershed, water quality curriculum, and classes. Also support agency, local government, and utility educational programs promoting actions by individuals to protect and conserve water resources.
- Coordinate briefings and presentations to civic, business, trade, environmental, conservation, and fishing organizations on the regional recovery program, actions, and progress.
- Establish regional measures to acknowledge and celebrate the contributions of organizations, businesses, and individuals. Publicize incentive programs for the protection and restoration of water resources and habitat and encourage landowner participation.
- Encourage business and professional organizations to adopt and promote implementation of best management practices for the protection and restoration of fish and habitat.
- Encourage and assist local or community organizations interested or involved in watershed and habitat protection and restoration.
- Develop a resource publication to assist implementing partners and the public with funding education and recovery programs and projects.

In concert with the development of the public education and outreach plan, the implementing partners will be requested to prepare an education and outreach plan for their implementing activities. While public entities are already required by law or rule to have some form of public education and outreach, these plans would help to strengthen efforts by the implementing partners are consistent with the principles and regional program discussed above and coordinated with the efforts of other implementing partners.

8.6 Funding Strategy

As indicated in Section 6, recovery of listed fish species in the Upper Columbia Basin may cost at least 125 million dollars. A major uncertainty is exactly how recovery will be funded. HCPs and binding mitigation agreements help guarantee that some programs (e.g., state-run mitigation hatchery programs, tributary habitat fund, etc.) have secure funding and will continue operating into the future. However, these programs fall well short of funding the total needs of this plan. Additional funding will be required to implement this recovery plan.

8.6.1 Funding Sources

This plan will rely on the following funding sources to aid in implementing the Upper Columbia Salmon Recovery Plan.

- The Washington Salmon Recovery Funding Board.
- Public Utility District funds.
- The Bonneville Power Administration (BPA) Fish and Wildlife Program.
- The Federal Columbia River Power System Biological Opinion.
- Appropriations from the Washington State Legislature for state agency budgets (WDFW, WDOE, Conservation Districts).
- Pacific Coast Salmon Recovery Fund (NMFS).
- Appropriations from the U.S. Congress for federal agency (USACE, USFWS, USGS, USFS, NRCS, BOR, and BLM).
- Local government mechanisms funded through state legislative appropriations.
- Other nongovernmental organizations such as the National Fish and Wildlife Foundation, Regional Fishery Enhancement Groups, the Bonneville Environmental Foundation, and the Bullitt Foundation.
- NOAA Community-Based Restoration Program.
- Voluntary projects funded through public and private partnerships.

The UCSRB recommends that in addition to funding recovery actions, funding sources shall also pay for all monitoring and evaluation activities associated with recovery actions.

8.6.2 Order In Which Projects Will Be Funded

Projects will be funding according to the prioritization framework described in Section 8.3.1. In short, the prioritization of projects for funding will be based on a balance between the biological benefit of the project and the cost and feasibility of implementing the project (see Figure 8.3).

Projects that address primary limiting factors, have high biological benefit, are relatively inexpensive, and are feasible to implement will receive highest funding priority. Projects that are expensive, have low biological benefit to listed fish species, and have relatively low feasibility will receive lowest funding priority.

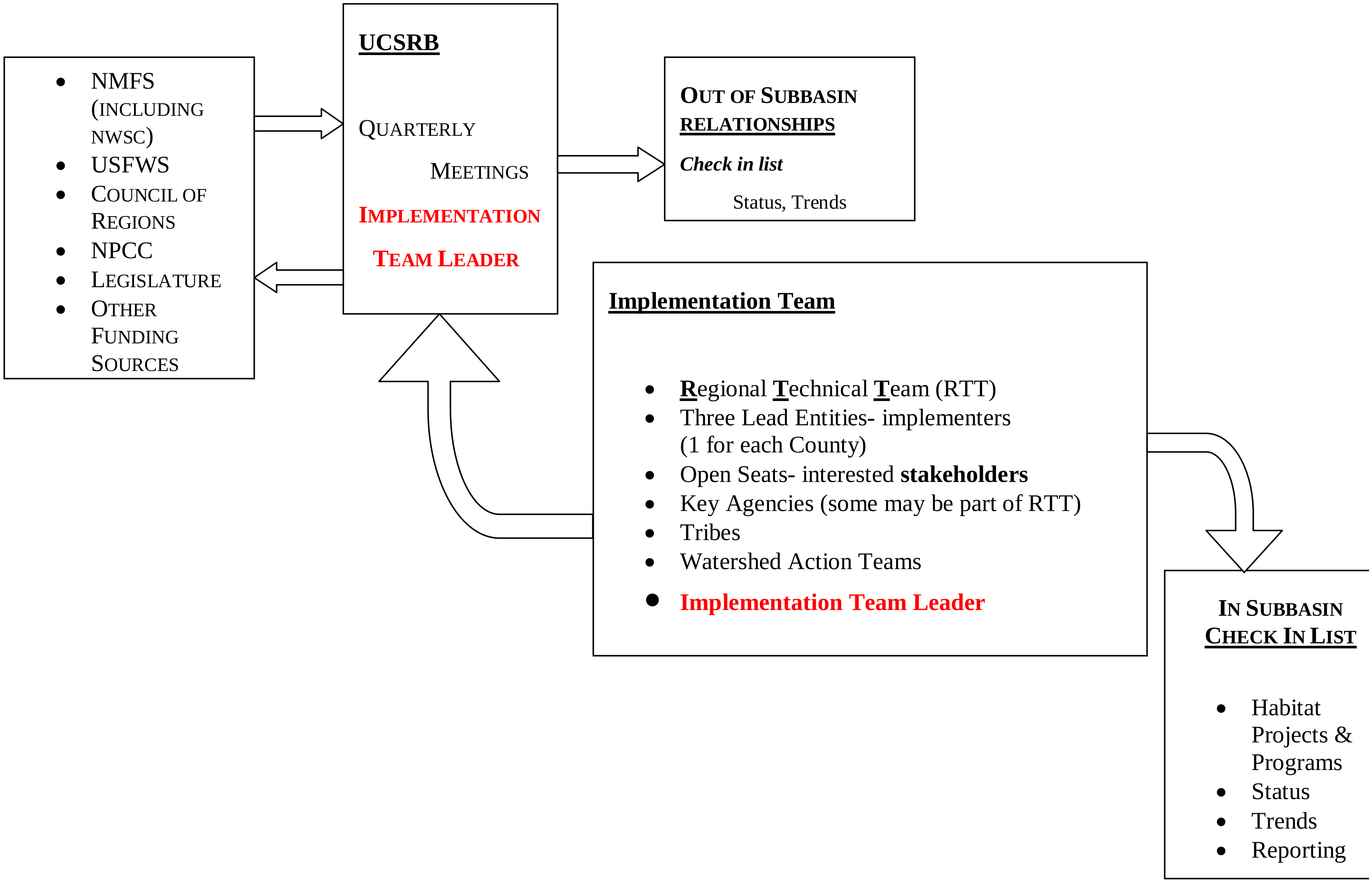

Figure 8.1 Diagram showing implementation structure

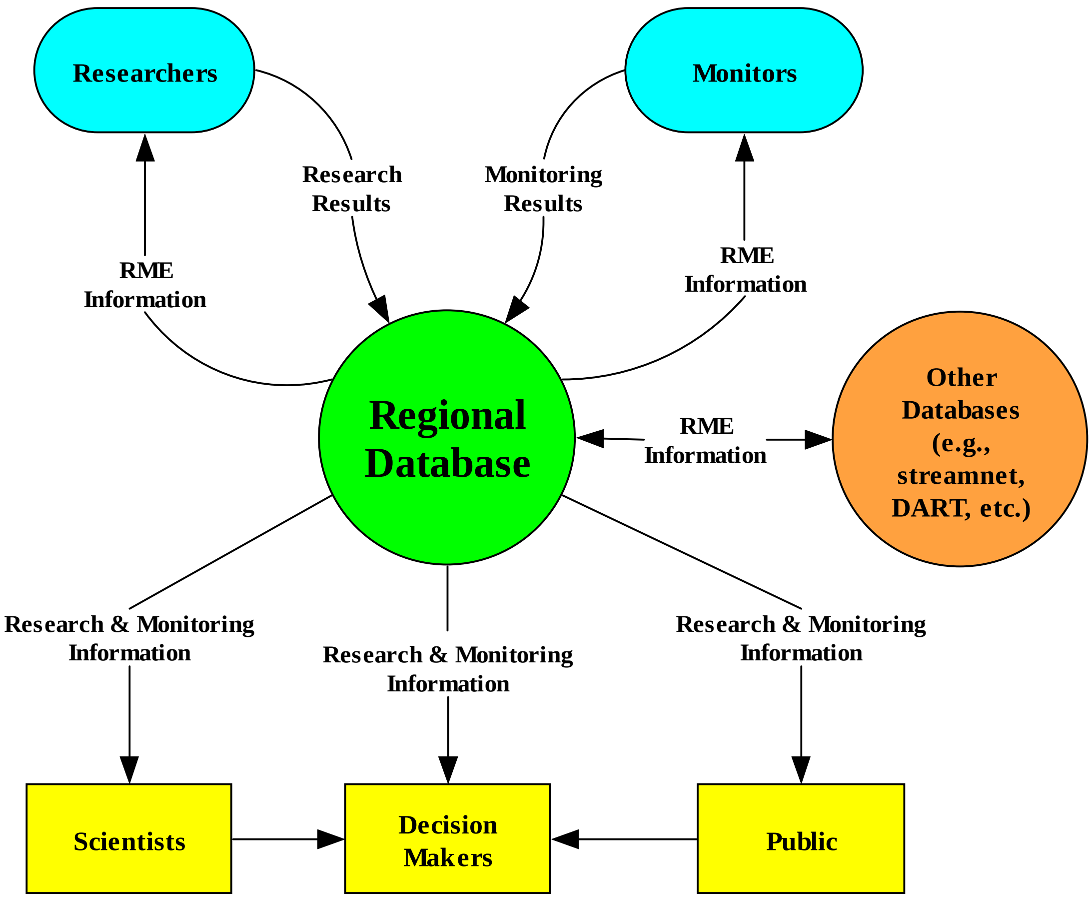

Figure 8.2 Diagram showing the flow of information from researchers and monitors in the Upper Columbia Basin to scientific reviewers, public, and decision makers.

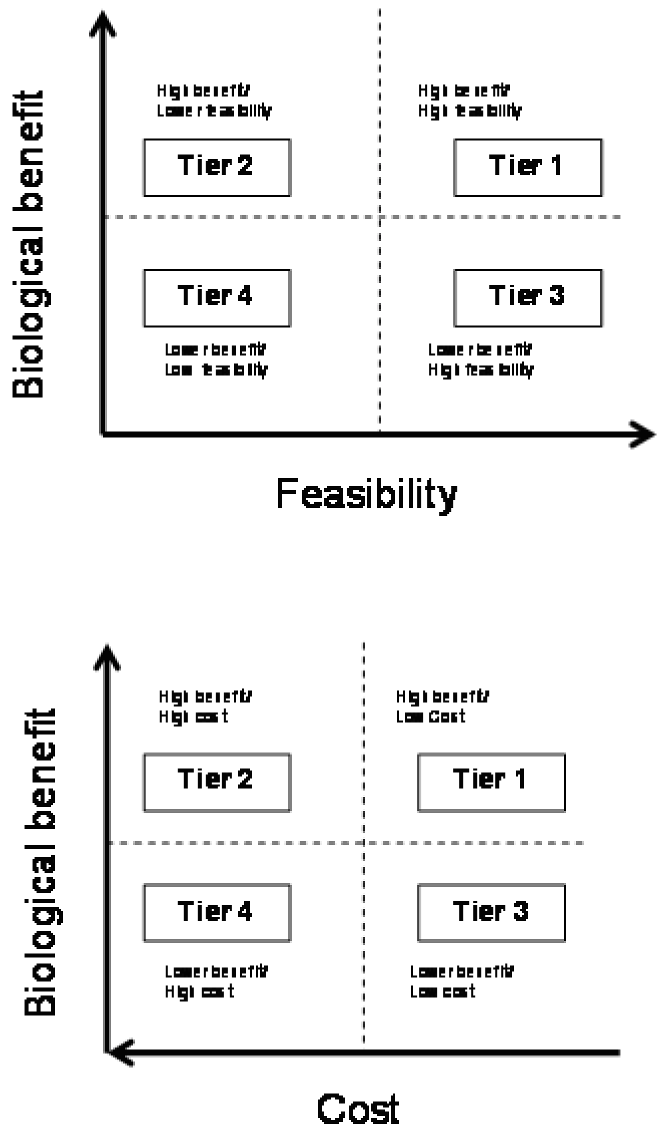

Figure 8.3 Relationships between biological benefits, costs, and feasibility for prioritizing (sequencing) recovery actions. Tier 1 actions receive the highest priority, while Tier 4 actions receive the lowest.

9 Acronyms

ACOE	Army Corps of Engineers
ADA	Americans with Disabilities Act
AHA	All H Analyzer
APRE	Artificial Production Review and Evaluation
BAMP	Biological Assessment and Management Plan
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BMPs	Best Management Practices
BO	Biological Opinion
BOD	Biological Oxygen Demand
BOR	U.S. Bureau of Reclamation
BPA	Bonneville Power Administration
C&S	ceremonial and subsistence
CAO	Critical Area Ordinances
Colville Tribes	Confederated Tribes of the Colville Nation
CPUD	Chelan County Public Utility District
CREP	Conservation Reserve Enhancement Program
CRFMP	Columbia River Fish Management Plan
CSMEP	Collaborative, Systemwide Monitoring and Evaluation Project
CTH	Colville Trout Hatchery
CWT	coded wire tag
DNA	deoxyribonucleic acid, genetic information
DPS	distinct population segment
DPUD	Douglas County Public Utility District
EDT	ecosystem diagnosis and treatment
EFC	Evergreen Funding Consultants
EIBS	erythrocytic inclusion body syndrome
EMAP	Environmental Monitoring and Assessment Program

ENFH	Entiat National Fish Hatchery
ESA	Endangered Species Act
ESU	evolutionarily significant unit
EWU	Eastern Washington University
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FR	Federal Register
FRD	Fruit Reporting Districts
FRN	Federal Register Notice
FWEE	Foundation for Water and Energy Education
GCFMP	Grand Coulee Fish Maintenance Project
GM	geometric mean, sometimes specific to 12-year span
GMA	Growth Management Act
GPUD	Grant County Public Utility District
HB	House Bill
HCP	Habitat Conservation Plan
HE	hatchery effectiveness
HGMP	Hatchery and Genetic Management Plan
HSRG	Hatchery Scientific Review Group
IAC	Interagency Committee for Outdoor Recreation
ICBTRT	Interior Columbia Basin Technical Recovery Team
ISAB	Independent Scientific Advisory Board
ISRP	Independent Scientific Review Panel
IHN	infectious hepatopoietic necrosis
IPNV	infectious pancreatic necrosis virus
LNFH	Leavenworth National Fish Hatchery
LWD	Large Woody Debris
MFHC	Methow Fish Hatchery Complex
NCW	North Central Washington

NFH	National Fish Hatchery
NIIP	National Income Indicators Project
NMFS	National Marine Fisheries Service
NNI	no net impact
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPPC	Northwest Power Planning Council
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NWFSC	Northwest Fisheries Science Center
PATH	Plan for Analyzing and Testing Hypotheses
PCSRF	Pacific Coastal Salmon Recovery Fund
PFMC	Pacific Fishery Management Council
PIT	passive integrated transponder
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PSC	Pacific Salmon Commission
PUD	Public Utility District
QAR	Quantitative Analysis Report
QHA	quantitative habitat analysis
RCW	Revised Code of Washington
RIFHC	Rock Island Fish Hatchery Complex
RME	research, monitoring, and evaluation
RMEG	Recovery Monitoring and Evaluation Technical Group
RTT	Regional Technical Team
SAR	smolt-to-adult return rate
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
TAC	***U.S. v Oregon*** Technical Advisory Committee
TMDL	Total Maximum Daily Load

TRT	Technical Recovery Team (see ICBTRT)
UCB	Upper Columbia Basin
UCHCC	Upper Columbia Habitat Coordination Committee
UCR	Upper Columbia Region
UCRTT	Upper Columbia Regional Technical Team
UCSRB	Upper Columbia Salmon Recovery Board
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VSP	viable salmonid population
WAESD	Washington State Employment Security Department
WASS	Washington Agricultural Statistics Service
WAT	Watershed Action Teams
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WFH	Wells Fish Hatchery
WMA	Watershed Management Act
WNFH	Winthrop National Fish Hatchery
WRIA	watershed resource inventory area
WSU	Washington State University
YN	Yakama Nation

10 Glossary

abundance. Refers to the total number of individual organisms in a population or subpopulation. In this plan, abundance refers to the total number of spawning adults within a population.

adaptive management. A management process that applies the concept of experimentation to design and implementation of natural resource plans and policies.

adaptive trait. Characteristics that improve an individual's survival and fitness.

adfluvial bull trout. Bull trout that migrate from tributary streams to a lake or reservoir to mature (one of three bull trout life's histories). Adfluvial bull trout return to a tributary to spawn.

age class. A group of individuals of a species that have the same age (e.g., 1 year old, 2 year old, etc).

aggrading stream. A stream that is actively building up its channel or floodplain by being supplied with more bedload than it is capable of transporting.

allochthonous. Includes all organic matter that a stream receives from production that occurred outside the stream channel. It often constitutes a larger fraction of a stream's total inputs of organic matter. (See autochthonous.)

alluvial. Pertaining to or composed of slits and clays (usually) deposited by a stream of flowing water. Alluvial deposits may occur after a flood event.

alluvial fan. A sedimentary deposit located at a topographic break such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and that has the shape of a fan, either fully or partially extended.

anadromous (fish). A fish that is hatched in fresh water, migrates to the ocean to grow and live as an adult, and then returns to freshwater to spawn (reproduce).

artificial propagation. The use of artificial procedures to spawn adult fish and raise the resulting progeny in fresh water for release into the natural environment, either directly from the hatchery or by transfer into another area.

autochthonous. Includes organic matter that is produced within the stream. Primary production by periphyton, macrophytes, and phytoplankton constitutes important autochthonous sources. (See allochthonous.**)**

bedload. Sediment particles that are moved on or immediately above the streambed, such as the larger heavier particles (gravel, boulders) rolled along the bottom; the part of the load that is not continuously in suspension.

braided stream. A stream that forms an interlacing network of branching and recombining channels separated by islands and channel bars. Generally a sign of stream disequilibrium resulting from transportation of excessive rock and sediment from upstream areas and characteristic of an aggrading stream in a wide channel on a floodplain.

bypass system (fish). Structure in a dam that provides a route for fish to move through or around a dam without going through the turbines.

canopy cover (of a stream). Vegetation projecting over a stream, including crown cover (generally more than 1 meter (3.3 feet) above the water surface) and overhang cover (less that 1 meter (.3 feet) above the water).

carrying capacity (fish). Refers to the predicted average maximum number of fish that can be sustained in a habitat over the long term.

channel morphology. The physical dimension, shape, form, pattern, profile, and structure of a stream channel.

channel stability. The ability of a stream, over time and in the present climate, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either aggrading or degrading.

channelization. The straightening and deepening of a stream channel to permit the water to move faster, to reduce flooding, or to drain wetlands.

char. A fish belonging to the genus Salvelinus and related to both the trout and salmon. The bull trout, Dolly Varden trout, brook trout, and the Mackinaw trout (or lake trout) are all members of the char family. Char live in the icy waters (both fresh and marine) of North America and Europe.

community. Any group of organisms belonging to a number of different species that co-occur in the same habitat or area and interact through trophic and spatial relationships.

community structure. Number of species and their abundance within a community.

complex interacting groups. Multiple local populations that may have overlapping spawning and rearing areas within a geographic area.

core area. The combination of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat) constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics for local populations inhabiting a core area provide a relative indication of the core area’s likelihood to persist. A core area represents the closest approximation of a biologically functioning unit for bull trout.

core habitat. Habitat that encompasses spawning and rearing habitat (resident populations), with the addition of foraging, migrating, and overwintering habitat if the population includes migratory fish. Core habitat is defined as habitat that contains, or if restored would contain, all of the essential physical elements to provide for the security of allow for the full expression of life history forms of one or more local populations of bull trout. Core habitat may include currently unoccupied habitat if that habitat contains essential elements for bull trout to persist or is deemed critical to recovery.

core population. A group of one or more bull trout local populations that exist within core habitat.

coterminous. Used of organisms having similar distributions.

Council of Regions. An ***ad hoc*** consortium of regional salmon recovery organizations in Washington State that improves coordination on salmon recovery issues.

Distinct Population Segment (DPS). A listable entity under the Endangered Species Act that meets tests of discreteness and significant according to U.S. Fish and Wildlife Service and NOAA Fisheries policy.

deposition (stream). The settlement of accumulation of material out of the water column and onto the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

depositional areas (stream). Local zones within a stream where the energy of flowing water is reduced and suspended material settles out, accumulating on the streambed.

discharge (stream). With reference to stream flow, the quantity of water that passes a given point in a measured unit of time, such as cubic meters per second or, often, cubic feet per second.

diversity. All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population.

domestication. The process of fish becoming genetically adapted to conditions of artificial propagation. Because fish are adapted to conditions of artificial propagation, their survival and the survival of their offspring is less than that for naturally produced fish that are genetically adapted to natural conditions.

ecoregion. A relatively uniform area defined holistically based on geology, climate, landform, soil, vegetation, and water.

ecosystem. A community of organisms and their physical environment interacting as an ecological unit.

effective population size. The number of breeding individuals that would give rise to the same amount of random genetic drift as the actual population, if ideal conditions held.

embeddedness. The degree to which large particles (boulders, gravel) are surrounded or covered by fine sediment, usually measured in classes according to percentage covered.

entrainment. Process by which aquatic organisms are pulled through a diversion, turbine, spillway, or other device.

Evolutionarily Significant Unit (ESU). A population or group of populations that is reproductively isolated from other population units and represents an important component in the evolutionary legacy of the species.

exotic. A non-native or foreign organism or species that has been introduced into an area.

extant. Existing or living at the present time.

extirpation. The total elimination of a species from a particular local area.

fecundity. The number of eggs readied for spawning by a female. It is usually expressed as the number of eggs per size (length or weight) of female.

fine sediment (fines). Sediment with particle sizes of 2.0 mm (.08 inch) or less, including sand, silt, and clay.

fish ladder. A device to help fish swim around a dam.

floodplain. Adjacent to stream channels, area that are typified by flat ground and are periodically submerged by floodwater.

flow regime. The quantity, frequency, and seasonal nature of water flow.

fluvial bull trout. Bull trout that migrate from tributary streams to larger rivers to mature (one of three bull trout life histories). Fluvial bull trout migrate to tributaries to spawn.

functionally extirpated. Describes a species that has been extirpated from an area; though a few individuals may occasionally be found, they are not thought to constitute a viable population.

genotype. The set of alleles (variants of a gene) possessed by an individual at a particular locus or set of loci.

geometric mean. A measure of central tendency that is applied to multiplicative processes (e.g., population growth). It is calculated as the antilogarithm of the arithmetic mean of the logarithms of the data.

habitat connectivity (stream). Suitable stream conditions that allow fish and other aquatic organisms to move freely upstream and downstream. Habitat linkages that connect to other habitat areas.

hatchery produced fish. Fish produced from parents that were selected and spawned artificially.

headwaters. The source of a stream. Headwater streams are the small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers or run directly into larger streams and lakes.

hooking mortality. Death of a fish from stress or injury after it is hooked and reeled in, then released back to the water.

hybridization. Any crossing of individuals of different genetic composition, typically different species, that result in hybrid offspring.

hydrologic response. The response of a watershed to precipitation; usually refers to streamflow resulting from precipitation.

hydrologic unit (code). Watersheds that are classified into four types of units: regions, subregions, accounting units, and cataloging. The units from the smallest (cataloging units) to the largest (regions). Each unit is identified by a unique hydrologic unit code consisting of two to eight digits based on the four levels of classification in the hydrologic unit system.

hyporheic zone. Area of saturated sediment and gravel beneath and beside streams and rivers where groundwater and surface water mix. Water movement is mainly in a downstream direction.

independent population. A group of fish of the same species that spawns in a particular lake or stream at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season.

Interior Columbia Basin Technical Recovery Team (ICBTRT). Expert panel formed by NOAA Fisheries to work with local interests and experts and ensure that ICBTRT recommendations for delisting criteria are based on the most current and accurate technical information available.

intermittent stream. A stream that flows only at certain times of the year as when it receives water from springs (or by surface water) or when water losses from evaporation or seepage exceed the available streamflow.

interspecific competition. Competition for resources between two or more different species.

intrinsic potential. The potential of the landscape to support a fish population. It is used when historic population characteristics are unknown.

introgression (genetic). The spread of genes of one species into the gene pool of another by hybridization or by backcrossing (interbreeding between hybrid and parental species).

legacy effects. Impacts from past activities (usually a land use) that continue to affect a stream of watershed in the present day.

limiting factor. A factor that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.

local population. A group of fish of the same species that spawn within a particular stream or portion of a stream system. Multiple local populations may exist within a core area. A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

mass wasting. Loss of large amounts of material in a short period of time, i.e., downward movement of land mass material or landslide.

metapopulation. A group of semi-isolated subpopulations of a species that are interconnected and that probably share genetic material.

metrics. A measurement that identifies or describes a subject or object. For example, the number of major spawning areas within an area is a metric.

migratory corridor. Stream reaches used by fish to move between habitats. A section of river or stream used by fish to access upstream spawning areas or downstream lake or ocean environments.

migratory life-history form (bull trout). Bull trout that migrate from spawning and rearing habitat to lakes, reservoirs, or larger rivers to grow and mature.

morphology. Refers to the form and structure of an organism, with special emphasis on external features.

naturally produced. Fish produced from naturally spawning parents.

niche. The ecological role of a species in a community. It is conceptualized as the multidimensional space of which the coordinates are the various parameters representing the condition of existence of the species.

nonnative species. Species not indigenous to and area, such as brook trout in the western United States.

occupancy unknown. Refers to areas in which fish (e.g., bull trout) occurred historically, but their current status (presence) is unknown.

peak flow. Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.

phenotype. Expressed physical, physiological, and behavioral characteristics of an organism that may be due to genetics, the environment, or an interaction of both.

piscivorous. Describes fish that prey on other fish for food.

potential local population. A local population that does not currently exist, but that could exist, if spawning and rearing habitat or connectivity were restored in the area, and contribute to recovery in a known or suspected unoccupied area.

precocious. Maturing particularly early in development.

probability of persistence. The probability (usually expressed as a percentage) that a population or subpopulation of fish will survive and be present in a specific geographic location through some future time period, usually 100 years.

productivity. A measure of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over a entire life cycle. In this plan, productivity is measured as recruits per spawner (spring Chinook and steelhead) or the long-term trend in numbers of adults (bull trout).

recovery subunit (bull trout). Portions of larger recovery units treated separately to improve management efficiency.

recovery unit (bull trout). Recovery units are the major units for managing recovery efforts; each recovery unit is described in a separate chapter in the recovery plan. A distinct population segment may include one or several recovery units. Most recovery units consist of one or more major river basins. Several factors were considered in our identifying recovery units, for example, biological and genetic factors, political boundaries, and ongoing conservation efforts. In some instances, recovery unit boundaries were modified to maximize efficiency of established watershed groups, encompass areas of common threats, or accommodate other logistic concerns. Recovery units may include portions of mainstem rivers (e.g., Columbia and Snake rivers) when biological evidence warrants inclusion. Biologically, recovery units are considered groupings of bull trout for which gene flow was historically or is currently possible.

recruitment. The successful addition through birth and death of new individuals (fish) to a specific population.

redd. A nest constructed by female fish of salmonid species in streambed gravels where eggs are deposited and fertilization occurs. Redds can usually be distinguished in the streambed gravel by the cleared depression, and an associated mound of gravel directly downstream.

resident life history form (bull trout). Bull trout that do not migrate, but that reside in tributary streams their entire lives (one of three bull trout life cycles).

riparian area. Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

salmonid. Fish of the family salmonidae, including trout, salmon, chars, grayling, and whitefish. In general usage, the term most often refers to salmon, trout, and chars.

scour. Concentrated erosive action by stream water, as on the outside curve of a bend; also, a place in a streambed swept clear by a swift current.

smolt. A juvenile salmon or steelhead migrating to the ocean and undergoing physiological and behavioral changes to adapt its body from a freshwater environment to a saltwater environment.

source population. Strong subpopulation that are within a metapopulation and that contribute to other subpopulations and reduce the risk of local extinctions.

spatial structure. The geographic distribution of a population and all the processes that affect the distribution.

spawning and rearing habitat. Stream reaches and the associated watershed areas that provide all habitat components necessary for spawning and juvenile rearing for a local fish population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident of migratory fish and may also support subadults and adults from local populations of resident fish.

spawning escapement. The number of adult fish from a specific population that survive spawning migrations and enter spawning grounds.

spillway. The part of the dam that allows high water to flow (spill) over the dam.

stochastic. The term is used to describe natural events or processed that are random. Examples include environmental conditions such as rainfall, runoff, and storms, or life-cycle events, such as survival or fecundity rates.

stock. The fish spawning in a particular lake or stream(s) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season. A group of fish belonging to the same population, spawning in a particular stream in a particular season.

storage reservoir. An artificial storage place for water, from which the water may be withdrawn for irrigation, municipal water supply, or flood control.

subwatershed. Topographic perimeter of the catchment area of a stream tributary.

suspended load (washload). The part of the total stream load that is carried for a considerable period of time in suspension, free from contract with the stream bed, it consists mainly of silt, clay, and sand.

suspended sediment. Solids, either organic or inorganic, found in the water column of a stream or lake. Sources of suspended sediment may be either human induced, natural, or both.

take. Activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or attempt to engage in any such conduct to a listed (Endangered Species Act) species.

tolerance. Represents the range of an environmental factor (e.g., temperature, fine sediment, water velocity, etc.) within which an organism or population can survive.

transplantation. Moving naturally produced fish from one stream system to another without the use of artificial propagation.

trophic status. Referring to the nourishment status or biological productivity of a water body; determined largely by nutrient concentrations (i.e., phosphorous and nitrogen) and the resultant synthesis of organic compounds by green plants in the presence of these nutrients and light energy.

uncertainty. A lack of knowledge about stochastic events and the ecological and social processes that affect fish.

viable population. An independent population that has negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe.

viability curve. A curve showing the relationship between population abundance and productivity. Populations that fall above the curve are at a lower risk of extinction than populations that fall below the curve.

water right. Any vested or appropriation right under which a person may lawfully divert and use water. It is a real property right appurtenant to and severable from the land on or in connection with which the water is used; such water right passed as an appurtenance with a conveyance of the land by deed, lease, mortgage, will, or inheritance.

watershed. The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridged of higher ground generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

woody debris. Woody material such as trees and shrubs; includes all parts of a tree such as root system, bowl, and limbs. Large woody debris generally refers to the woody material whose smallest diameter is greater than 10 centimeters, and whose length is greater than 1 meter.

year class (cohort). Fish in a stock spawned in the same year. For example, the 1997 year class of steelhead includes all steelhead spawned in 1997, which would be 1 in 1998. Occasionally, a stock produces a very small or very large year class that can be pivotal in determining stock abundance in later years.

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